DRIVER SPEED LIMIT COMPLIANCE IN SCHOOL ZONES:

ASSESSING THE IMPACT OF SIGN SATURATION

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16. Abstract

School zones are often viewed as an effective way to reduce driving speeds and thereby improve safety near our nation's schools. The effect of school zones on reducing driving speeds, however, is minimal at best. Studies have shown that over 90% of drivers exceed speed limits posted in school zones (Trinkaus, 1996; Trinkaus, 1998). Many drivers report that their lack of speed reduction was based on the fact that they were unaware that they were in a school zone (Ash, 2006). Researchers have investigated methods used to increase driver compliance for some time (McCoy, Mohaddes, & Haden, 1981). Based on the results of empirical studies, effective methods include increased enforcement (Dumbaugh & Frank, 2007), appropriate speed zone settings (Day, 2007; McCoy & Heimann, 1990), visual placement of school buildings and play equipment (Clifton & Kreamer-Fults, 2007), and speed monitoring devices (Ash, 2006; Lee et. al., 2006). In a recent study, Kattan, et al., (2011) found that in the situation when there is 2-lane roads, roads with fencing, traffic control devices and the presence of speed display device or children, and zones that were longer, drivers' mean speed was lower and the rate of compliance was higher.

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1. Introduction

School zones are often viewed as an effective way to reduce driving speeds and thereby improve safety near our nation's schools. The effect of school zones on reducing driving speeds, however, is minimal at best. Studies have shown that over 90% of drivers exceed speed limits posted in school zones (Trinkaus, 1996; Trinkaus, 1998). Many drivers report that their lack of speed reduction was based on the fact that they were unaware that they were in a school zone (Ash, 2006).

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Traffic engineers and city planners have utilized a variety of school zone signage in an attempt to improve compliance. Signs, flashers, and roadway markings have all been implemented. While some studies have shown a positive effect of signs on reducing speed (Schrader, 1999), others argue that signs have no effect on driver compliance with posted speed limits (Simpson, 2008), leading to a lack of conclusive evidence on the value of school zone signage (Dumbaugh& Frank, 2007; Lee & Bullock, 2003).

In many municipalities, school zone signs are often placed based on public requests or political pressure. There is a clear lack of empirical evidence to demonstrate that the addition of such signs reduces driver speed. Furthermore, the addition of too many signs in a given area may actually reduce driver compliance. Based on models of human information processing, if a driver observes too many of the same stimulus, he or she no longer attends to the stimulus with a great deal of attention (Wickens et. al., 2004). This leads to a driver not noticing a particular stimulus.

In the case of school zone signs, the presence of too many signs in a compact area could lead to the same phenomenon. The presence of multiple school zones on a driver's route may lead the driver to ignore the zones altogether. Mississippi communities are home to many schools and thereby school zones. However, along with these school zones comes a lack of enforcement of posted speeds. The effectiveness of additional zones can be questioned, particularly if oversaturation of the signage leads to inattention. A balance between novelty and oversaturation of a stimulus must be reached to maximize a school zone's effectiveness at reducing driver speeds.

Adding a new school zone would be beneficial if it led to a reduction in crashes (in a previously unsafe location) or to an increase in compliance with posted speeds. The addition of a new school zone would be detrimental if it would lead to oversaturation, thereby diverting driver attention from multiple school zones in the municipality. This project aims to quantify the impact of increasing school zone saturation

on driver compliance behavior, thereby allowing transportation officials the ability to make informed decisions on the expected benefits of adding school zone signage throughout Mississippi.

2. Project Objectives

The objective of this project was to evaluate the impact of school zone sign density on reducing driver speed and increasing driver compliance in school zones. The results were used to inform guidelines for use by MDOT regarding the placement of school zone signage throughout Mississippi.

3. Methodology

3.1 Variables

3.1.1 Dependent Variables

According to the study objective, two dependent variables were used: vehicle speed is measured as a continuous variable. It is the speed of each vehicle when they pass the measure point (the spot where Quixote NC-200 is placed) within the school zone. Vehicle compliance is measured as a binary variable. It is coded as either "1" (the vehicle complied with the speed limit posted in school zone) or "0" (the vehicle failed to comply with the speed limit posted in school zone).

3.1.2 Independent Variables

We studied two independent variables in this project. The first was sign saturation (see Appendix A). Sign saturation refers to the density of other school zones (and thereby school zone signs) in the surrounding area. For this study, any school zones located within a 10 mile radius of the school zone were included in the saturation measure. School zones with a saturation of at least 10 were categorized as "high saturation." School zones with a saturation of less than 2 were categorized as "low saturation." The cutoffs for the categories are arbitrary to some extent with the intention of keeping the low density and high density categories as far apart as possible to be able to estimate the impact of saturation on speed compliance with high clarity. There are total of 489 school zones in the state of Mississippi. According to the above categorization scheme, the state of Mississippi contains 37 high saturation school zones and 68 low saturation school zones. The rest of the school zones are considered medium density, and were not considered candidates for data collection in this study. The second independent variable, road type, is defined as the number of lanes on the road, excluding any turn lanes. In this study, road type had two levels: 2-lane and 4-lane.

3.1.3 Control Variables

Several control variables were included in an attempt to isolate the effect of the independent variables. Control variables included accident frequency, sign type, and required speed reduction. All data collection sites had the same values for all of these measures (accident frequency = low, sign type = static with no flashers, required speed reduction = 10mph from 45 mph to 35mph).

3.2 Procedure

3.2.1 Calculation of Sign Saturation

Prior to this project, sign saturation for school zones had not been quantified in Mississippi. Using the sign inventory provided by MDOT, sign saturation was calculated for each school zone in the state. Latitude and longitude of each sign was used to estimate individual school zones. Any school zone signs within a 750 yard radius were approximated to belong to the same school zone. Saturation was quantified as the total number of other school zones within a 10 mile radius of the school zone being studied. Additional details on the calculation of saturation measures can be found in Appendix A. A list of saturation details of all school zones within the state of Mississippi is provided in Appendix B.

3.2.2 Site Selection

Four school zones were selected for data collection (see Table 1). Each school zone requires a 10mph speed reduction (45mph to 35mph) and contains a static school zone speed limit sign with no flashers. The school zones represent high and low saturation areas. They also include both two-lane and four-lane roadways.

Table 1. School Zone Information

School Zone	Location	GPS Coordinates	Sign Saturation	Number of Lanes
A	Shannon (Hwy 145 and E Cherry St)	34.1214, -88.7123	High	2
B	Tupelo (N Gloster St and Leake St)	34.263, -88.7158	High	4
C	Amory (Hwy 25 and S Harmony Rd)	33.9356, -88.4827	Low	2
D	Belzoni (Hwy 49W and Pluck Rd)	33.1658, -90.4988	Low	4

When selecting the four school zones, we aimed to minimize arterial roadways and traffic signals that would impact driver speed within the school zone. Sketches of the four school zones and their surrounding road conditions were provided in Appendix D (Figures D1, D4, D7, D10). To further minimize the impact of these factors, the magnetic traffic sensors were placed within the school zone, 100 feet downstream from the school zone speed limit sign. Additionally, data with low speed values (less than 10 mph) were removed from the data set, as the vehicle was likely turning and not acting as through traffic.

3.2.3 Equipment

Data were collected for one week (7 days) at each of the four selected sites. Data were collected using QTT NC-200™ Portable Traffic Analyzers™ from the research team's research laboratories and from the Mississippi Department of Transportation (Figure 1). The cover was used to protect the traffic analyzer and stabilized it on the ground.

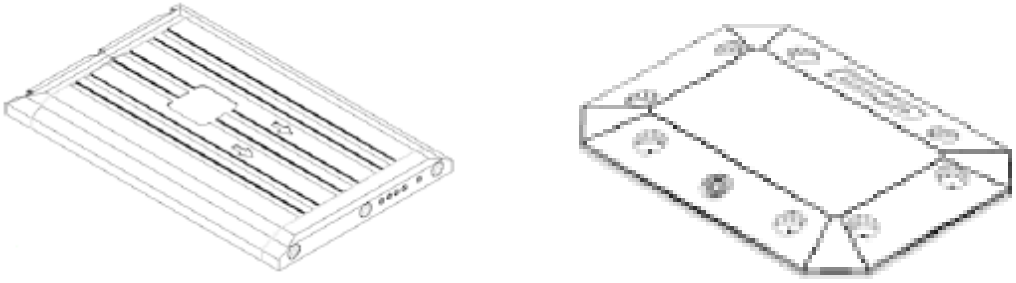

Figure 1. QTT NC-200™ Portable Traffic Analyzer™ and its Cover

The Traffic Analyzers use Vehicle Magnetic Imaging (VMI) to detect vehicles and capture related data as they move through the earth's magnetic field. All motor vehicles are constructed with iron parts. When a vehicle passes over the Traffic Analyzer, the iron parts interfere with the earth's magnetic field, generating a series of electrical signal change in the traffic analyzer sensors, which record and store the signal as the data. Therefore, the traffic analyzer can detect vehicle presence, vehicle count, vehicle speed, record vehicle length, etc. (NC-100 NC-200 Operations Manual, 2006). The traffic analyzer sensor recorded data in a time-stamped format. This allowed analysis based on time of data and traffic density. A single analyzer sensor was installed in each lane of the study site. The analyzer sensor continuously recorded data throughout the data collection period.

3.2.4 Data Collection

The traffic analyzers were programmed so that the data collection was continuous for an complete seven days. The data collection in school zones A and B started on Wednesday at 4:00 p.m. and stopped the next Wednesday at 4:00 p.m. The data collection in school zone C started on Tuesday at 4:00 p.m. and stopped the next Tuesday at 4:00 p.m. The data collection in school zone D started on Thursday at 4:00 p.m. and stopped the next Tuesday at 4:00 p.m.

For all four data collections, the research team was on site together with MDOT personnel. The research team was responsible for programming the traffic analyzer determining the exact location to install the traffic analyzers. MDOT personnel were responsible for traffic control and installing the traffic analyzers on the road. MDOT personnel were also responsible for retrieving the traffic analyzers after the data collection period was complete.

Data was extracted using a Highway Data Management (HDM) software package developed by Quixote. Data were exported to excel format and cleaned by the research team. The data set was truncated based on school session days and times (see Table C1). One hour of morning data (30 minutes prior to and 30 minutes after school start time) and one hour of afternoon data (30 minutes prior to and 30 minutes after school dismissal time) were included in the data set for analysis. Any data outside of this time window were removed. Vehicles that travelled below 10 mph were also removed as they are considered turning or stopping.

4. Results

4.1 Sign Saturation

Descriptive statistics for density are shown in Table 2. The average density for school zones in Mississippi was 4.55. Therefore, a school zone in Mississippi has, on average, 4.55 other school zones within a 10 mile radius of its location. Figure 2a and Figure 2b show the distribution of the density numbers.

Table 2. Descriptive Statistics of Density Numbers Mississippi School Zones

	State of Mississippi	District 1	High Saturation	Low Saturation
Mean	4.55	5.33	11.59	0.62
SD	3.05	3.36	1.26	0.49
Minimum	0	0	10	0
Maximum	15	14	15	1
Count	488	79	37	68

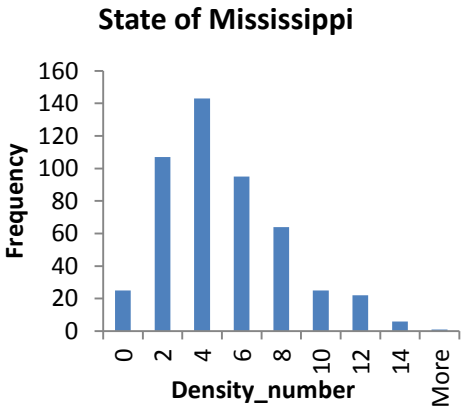

Figure 2a

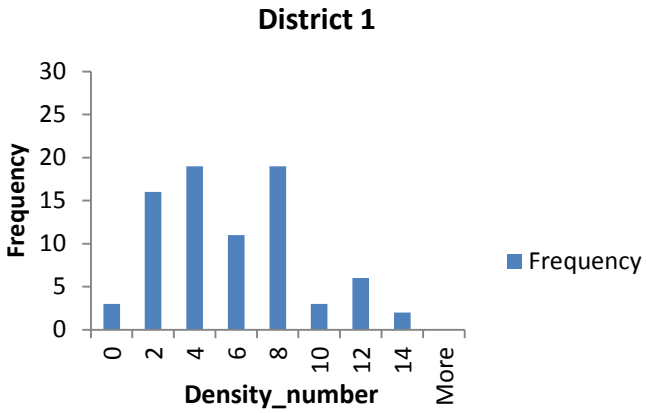

Figure 2b

Figure 2. The distribution of the density numbers for State of Mississippi (2a) and district 1 (2b)

4.2 Descriptive Measures of Driver Behavior

Driver speed is measured as the vehicle speed within school zones. Driver compliance was recorded as "1" if the vehicle speed was less than 35 (the school time speed limit) and "0" otherwise. The descriptive measures of driver behavior in all four school zones are provided in Table 4. Figure 3 shows the histogram of speeds for each of the four school zones. Histograms and time series graphs of speed data within each separate school zone is provided in Appendix D.

Table 4. Descriptive measures of driver behavior in all four school zones

Location	Number of Lanes	Saturation	Number of observations (n)	Vehicle Speed				% Compliance with Posted Speed Limit (35 mph)
				Mean	SD	Min	Max	
A	2	High	3824	43.87	9.94	16	72	20.19
B	4	High	13184	35.88	7	16	70	46.79
C	2	Low	5149	50.88	7.41	17	72	2.56
D	4	Low	6487	48.42	8.56	16	72	7.23

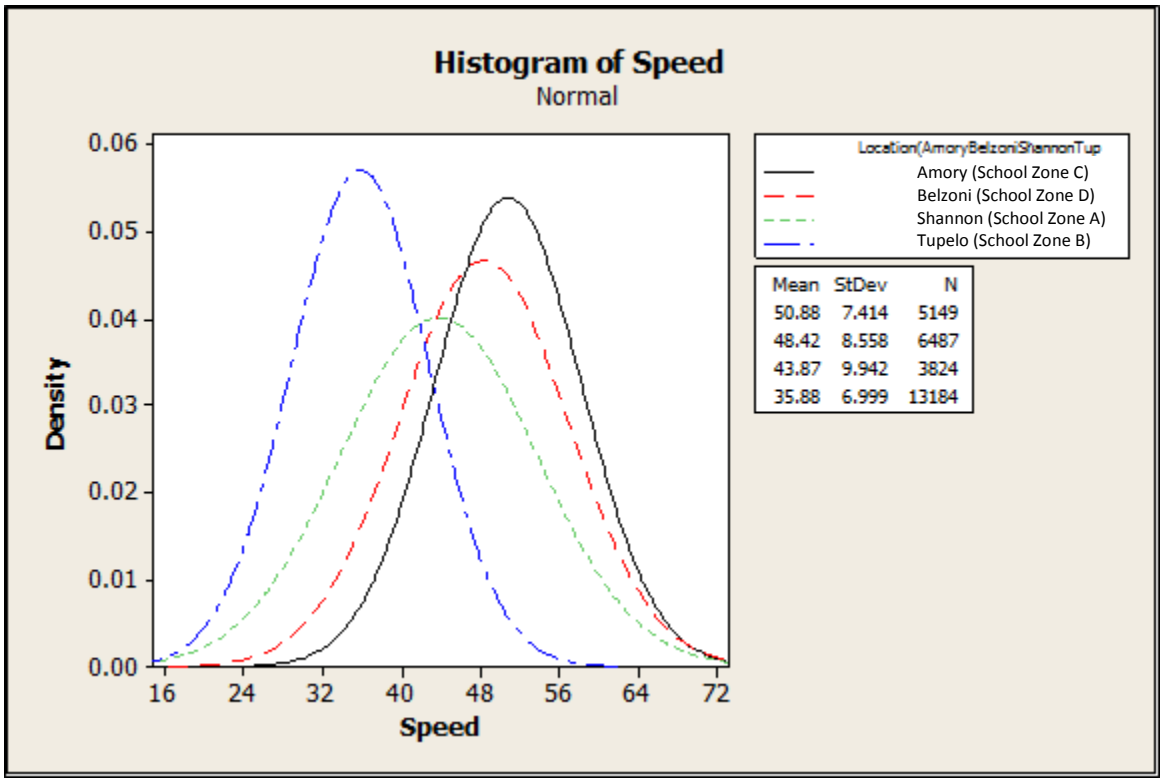

Figure 3. Histogram of speeds for four school zones.

4.3 Saturation and Driver Behavior

A 2X2 factorial ANOVA was performed with vehicle speed as the dependent variable and lane number and sign saturation as the independent variables. Results (Table 5) show that both main effect of lane number ($F(1, 28640) = 2557.28$, $p<0.0001$) and sign saturation ($F(1, 28640) = 8955.22$, $p<0.0001$) are significant. In addition, the interaction effect is also significant ($F(1, 28640) = 714.58$, $p<0.0001$). The R-Square value for the model is 0.40.

Table 5. AVOVA results of vehicle speed.

Source	DF	SS	MS	F	P
Lane number	1	159095.5	159095.5	2557.28	< .0001
Saturation	1	557129.3	557129.3	8955.22	< .0001
Interaction	1	44456.12	44456.12	714.58	< .0001
Error	28640	1781775	62.21		
Total	28643	2954678			

Post-hoc analysis was conducted using Tukey-Kramer approach. The post-hoc results showed that drivers on 2-lane roads exhibited significantly higher vehicle speeds compared to 4-lane roads, but this effect was only significant for high sign saturation. (Figure 4). As such, there is a greater impact of saturation on 4-lane roads when compared to 2-lane roads.

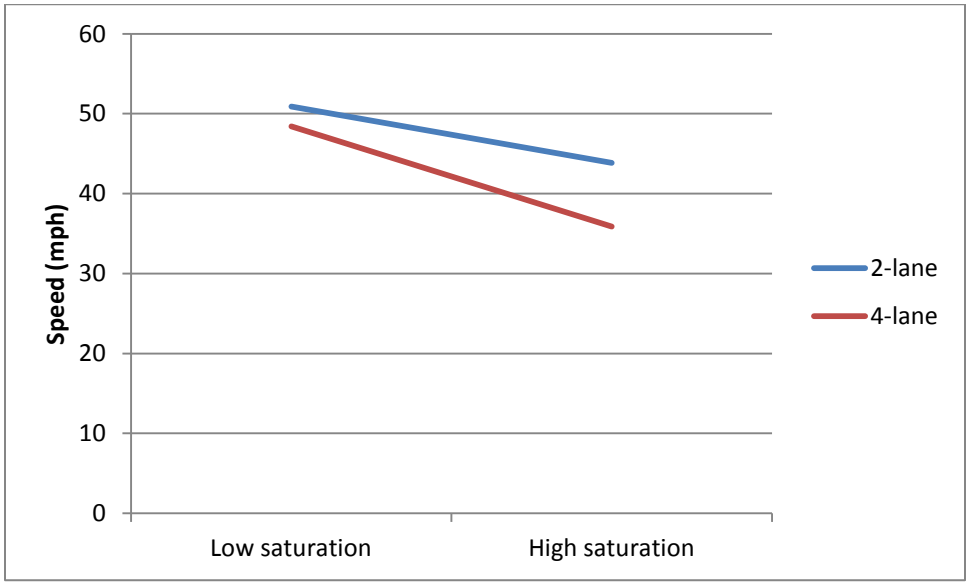

Figure 4. Interaction plot of drivers' speed

Chi-Square tests were conducted to examine the effect of lane number and sign saturation on vehicle compliance. Drivers had significantly higher compliance rates in 4-lane roads compared to 2-lane road ($\chi^2_{(1, N=28644)} = 1779.92$, $p < 0.0001$). Drivers' compliance for 4-lane road was 33.75% compared to 2-lane road with 10.07%. In addition, drivers exhibited significantly higher compliance in schools zones of high sign saturation ($\chi^2_{(1, N=28644)} = 4525.67$, $p < 0.0001$). School zones with high sign saturation exhibited driver compliance of 40.81% compared to school zones with low sign saturation with 5.17%. an interaction plot for compliance is provided in Figure 5. It shows that 4-lane road exhibited higher compliance compared to 2-lane road, and this effect is much greater for high sign saturation roads.

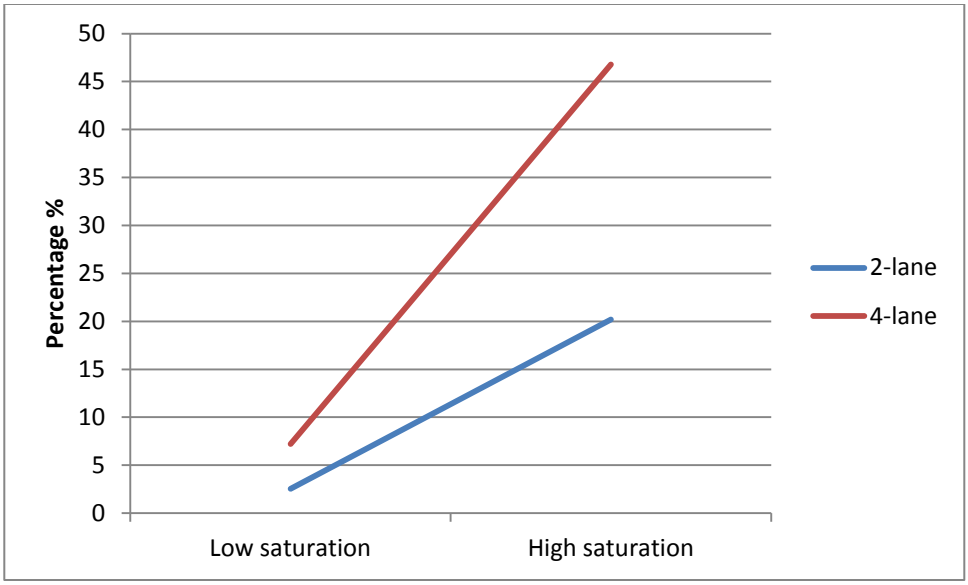

Figure 5. Interaction plot of drivers' compliance percentage

5. Discussion

The results showed that vehicle speeds were higher on 2-lane roads and in low sign saturation school zones. The vehicle compliance data indicated same result. This was contradictory to our hypothesis that drivers will comply more with the posted speed in low sign saturation school zones. The interaction effect indicated that drivers have higher compliance on 4-lane roads compared to 2-lane roads. This effect is more noticeable when sign saturation is high. This also shows that increasing sign saturation gained more benefit in a 4-lane road setting. There are several potential reasons leading to this result.

First, the data collected in school zone B greatly skewed the final results. School zone B alone accounts for 46.03% of the total data points because school zone B has a large traffic volume. Any significant effect could be due to the fact that school zone B is different from any of the other three locations of school zones.

Second, there are many confounding variables that were not be controlled or eliminated in the experiment. These confounding variables have great impact on the final results. For example, school zone B was identified as a metropolitan area while the other three school zones were located in rural areas. There is likely more law enforcement in school zone B compared to the other three school zones, which may skew the drivers' behavior. The high traffic density in school zone B during commuting hours also prevents drivers from driving freely. Therefore, the high driver compliance rate may not be due to the high sign saturation but rather due to the high traffic volume relative to the other locations.

Third, the surroundings of the school zones may also be a factor impacting the results. Four-lane school zones, especially school zone B has more complicated surroundings (more cross roads, more traffic lights, more nearby businesses and parking lots, etc.) than two-lane school zones. These surroundings may greatly influence driver behavior on the roads. It is possible that drivers have to slow down because

they are ready to make a right turn on the next crossroad. Although we trimmed the data to remove cars that were turning, drivers could have been slowing for an upcoming turn or other maneuver. This information is unknown and was not taken into consideration during data analysis.

6. Suggested Guidelines for School Zone Signage

Based on current data, vehicles in higher sign saturation and four-lane school zones exhibited lower vehicle speeds and higher driver compliance. In addition, it was observed that rural school zones exhibited higher vehicle speeds. Based on these results, we still do not have enough actionable information to inform standard policies for the placement of school zone signs. Additional work is needed. However, these initial findings can be used to inform sign placement as follows:

- There is no evidence of a negative impact of sign saturation. Place school zone signs as needed.
- Road type (number of lanes) has an impact on driver compliance in a school zone. A school zone located on a 4-lane road is more effective than a school zone located on a 2-lane road.
- There is evidence to suggest that drivers are more compliant to school zone signage in an urban setting. Place school zone signs in urban settings as needed.

The influence of other factors, such as road geometry, nearby traffic signals, and times of the day also need to be considered to develop a full list of sign installation guidelines.

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Appendix A: Sign Saturation Methodology

Table A1.School sign inventory from MDOT AMMO

Data Field	Description	Notes
BACKGROUND_COLOR	Color of sign	Strong yellow-green are school zone signs
LATITUDE	Location of sign (latitude)	Switched with longitude
LONGITUDE	Location of sign (longitude)	Switched with latitude
COUNTY_NMBR	Location of sign (county)	The number refers to the county in Mississippi, listed in alphabetical order (e.g. county 1 is Adams)
BEGIN_MI	Location of sign (distance in miles from county line)	Miles are counted South to North or West to East.
ROUTE_ID	Location of sign (name of roadway)	
FLASH_IND	Contains flashers or not	
HEIGHT_IN	Height of sign	
IMAGE_NAME	Describes content of sign	Also refer to STOCK_NMBR
INSTALLATION_DATE	When sign was installed	
LEGEND_COLOR	Color of content	
REPLACE_IND	Indicates whether sign needs replaced	
ROUTE_DIRECTION	Direction of travel on route	
SIGN_COMMENT	Notes from last survey	
SIGN_DAMAGE_IND	Indicates whether sign has damage	
SIGN_FACE_DIRECTION	Direction sign is facing	
SIGN_ID	Unique identifier for each sign	
LEGEND_TEXT	n/a	
STATUS_TYPE	n/a	
STOCK_NMBR	Sign number for fabrication shop	Refer to MDOT guide to stock numbers and signs
SUPPORT_CNT	Number of support structures	
SUPPORT_DAMAGE	n/a	
SUPPORT_DAMAGE_IND	Indicates whether support has damage	
SUPPORT_TYPE	Type of support used for sign	Signs larger than 36x36 require a pipe, smaller use post
SURVEY_DATE	Date of survey	
WIDTH_IN	Size of sign (width in inches)	
ITEMPIC	Picture of sign	Used only for non-standard and handmade signs; pictures only accessible on MDOT network
ROUTE_NAME	Location of sign	Refer to ROUTE_ID
HISTORICAL_IND	n/a	

A1. Calculated attributes

Following attributes have been calculated. Reader should notice that there are some other attributes in addition to "Density Number" and "Density per Square Mile". These two are the primary measures of sign saturation.

Density number (Density_number)

This is the primary measure of sign saturation. It expresses the total number of other school zones in close proximity of a given (reference) school zone. The area under consideration is a circular area designated by a radius surrounding the given school zone. So, if there are 10 school zones in an area with 10 mile radius surrounding a school zone, 10 is the density number for this school zone. Apparently, density number increases or stays the same with increasing radius of the area surrounding a school zone. However, using the same radius, one school zone having higher density number than another school zone has a higher sign saturation.

Density per square mile (Density_persqmile)

For the sake of comparison of sign saturations between two school zones, density number alone is enough as long as the radius under consideration is the same for both schools. However, density per square mile can work as a standard measure of sign saturation irrespective of the magnitude of the radius. If the density number of a school zone is 10 and the radius is 1 mile, then the density per square mile is equal to 10 divided by the area encapsulated by the 1 mile radius. With 1 mile radius, the area encapsulated is $\pi 1^2$ or 3.1416. The density per square mile is 10 divided by 3.1416, which is 3.1831. Now, if the density per square mile of another school zone is 4.51, sign saturation of this school zone is higher than that of the former school zone. The important point is that we do not need to know the radius used to calculate the density per square mile of the latter school zone to make the comparison. Instead of density per square mile, if we knew that the density number of the latter school zone is 15.5, we would also need the radius to be able to make a comparison between the two school zones. **Farthest distance (Far_distance)**

Farthest distance is the distance of the school zone within the given radius farthest from the reference school zone. This measure takes the fact into account that even though the area is expressed in terms of the radius, there might not be any school farther than a distance much smaller than the radius. In other words, this measure can be used to compare the compactness of sign saturation between any two schools.

Nearest distance (Near distance)

Nearest distance is the distance of the school zone within the given radius nearest from the reference school zone. It can be used to compare the degree of isolation of a school zone from its surrounding school zones.

Average distance (Avg_distance)

Average distance is the average of the distances of all the surrounding school zones from the reference school zone. It can be used to get an idea about how far on an average other school zones are from a given zone.

Number of accidents (Num_accidents)

It is the total number of accidents in close proximity of a school zone. The area designated as close proximity is the circular area around the middle point of a school with a radius of 750 yards (0.227 mile).

Average Severity (Average_Severity)

It is the average of severities of all the accidents in close proximity of a school zone.

A2. Methodology of Calculating Sign Saturation

The definition of sign saturation in our context suggests that multiple signs in the same school zone need to be converted into a single sign for the purpose of using individual signs to calculate the sign saturation of school zones. The available data is on individual signs rather than school zones, and there is no definite way to identify all the signs of the same school. The methodology works with the following steps:

1. For each of the individual signs, examine all the other signs to find out if they are in the same school zone as the sign under consideration is in, and remove all the other signs from the list of all signs that are in the same school zone. Latitudes and longitudes of a pair of signs are used to calculate their distance. If the distance is less than a pre-specified (750 yard or 0.426 mile) value considered being the probable maximum distance between two signs of a same school zone, this two signs are considered to be in the same school zone. Following is the formula used for calculating distance between two signs:
   distance = 0.621371*6371*acos(cos((3.14159/180)*(90-latitude1))*cos((3.14159/180)*(90-latitude2)) + sin((3.14159/180)*(90-latitude1))* sin((3.14159/180)*(90-latitude2))*cos((3.14159/180)*(longitude1-longitude2)));
   Even though the above method can deal with more than two signs per school zone, the data file that we used has only two signs per school zone, one as the beginning and the other as the end of the the zone in a particular driving direction. Therefore, the following formula gives the middle point of the school zone:
   MiddleLatitude = (latitude1+latitude2)/2;
   MiddleLongitude = (Longitude1+Longitude2)/2;
   The pre-specified value mentioned above is taken as 750 yards as it gives the number of school zones equal to about half of the total number of signs which should ideally be the case.
2. After applying the above step sequentially for all the signs, treat the remaining signs in the list of all signs as the identification signs of individual school zones.
3. Now for each of the individual school zones, examine all the other school zones to find out if they are in the area encapsulated by the pre-specified radius (10 miles) surrounding the school zone. This is done in the same way as was done for individual signs. At the end of this step, for each of the school zones, we have a list of school zones and their distances from the reference school zone. Either the coordinate of the identification sign or that of the middle point can be used in this step for distance calculation if the value of the radius is significantly greater than 750 yards. So, coordinates of the identification signs have been used here as the radius used is 10 miles or 17600 yards. For any radius less than 5 miles, middle point coordinates should be used instead to have a reasonably good accuracy of the calculated values.
4. Use the list of school zones and their distances from their reference school zone to calculate all the attributes. Apparently, the number of schools zones in the list of school zones is the density number.
5. Now for each of the individual school zone, examine all the accident locations to find out if they are in close proximity of the school zone. The procedure is the same as for getting school zones

from individual signs (step 1). At the end of this step, for each of the school zones, we will have a list of accident locations and their distances from the reference school zone. It is worth mentioning that middle points rather than individual signs of the school zones have been used for calculation of distances of accident locations from the school zones.

6. Use the list of accident locations and their distances from their reference school zone to calculate the attributes, Num_accidents and Average_severity. The total number of accidents in the list of accidents is apparently Number_accidents. Average_severity is the average of all the individual severity associated with each accident in the list of accidents.

A3. Calculation Example

Following are 10 signs with their longitudes and latitudes. In step 1, all the signs are merged into individual school zones. Then, in step 2, sign saturation of each school zone is calculated. Both step 1 and step 2 use a clustering mechanism (see methodology) where all the signs that are less than 750 yards apart, or all the school zones that are less than 10 miles apart are put in a single cluster as a school zone in the first case and as a closely located group of school zones in the second case. We assume that a sign cannot be part of more than 1 school zone and hence is deleted immediately from the initial list after being included in a cluster. We determine separate clusters for each school zone in step 2 to calculate sign saturation and other attributes.

Sign No.	longitude	latitude
1	-91.3793	31.5122
2	-91.3793	31.512
3	-91.3782	31.5373
4	-91.3781	31.5113
5	-91.3781	31.5113
6	-91.3777	31.5383
7	-91.3775	31.5391
8	-91.3775	31.5391
9	-91.377	31.5108
10	-91.377	31.5108

Step 1

Initial list of signs: 1 2 3 4 5 6 7 8 9 10

Check all the other signs to see if they are in the same school zone of sign 1

Distance between 1 and 1: 0

list of signs after deletion: 1 2 3 4 5 6 7 8 9 10

Distance between 1 and 2: 0.0141672

Distance < 0.284

list of signs after deletion: 1 3 4 5 6 7 8 9 10

Distance between 1 and 3: 1.73759

list of signs after deletion: 1 3 4 5 6 7 8 9 10

Distance between 1 and 4: 0.0944129

Distance < 0.284

list of signs after deletion: 1 3 5 6 7 8 9 10

Distance between 1 and 5: 0.0944129

Distance < 0.284

list of signs after deletion: 1 3 6 7 8 9 10

Distance between 1 and 6: 1.80688

list of signs after deletion: 1 3 6 7 8 9 10

Distance between 1 and 7: 1.86269
list of signs after deletion: 1 3 6 7 8 9 10
Distance between 1 and 8: 1.86269
list of signs after deletion: 1 3 6 7 8 9 10
Distance between 1 and 9: 0.161972
Distance < 0.284
list of signs after deletion: 1 3 6 7 8 10
Distance between 1 and 10: 0.161972
Distance < 0.284
list of signs after deletion: 1 3 6 7 8

Check all the other signs to see if they are in the same school zone of sign 3
Distance between 3 and 3: 0
list of signs after deletion: 1 3 6 7 8
Distance between 3 and 6: 0.0737346
Distance < 0.284
list of signs after deletion: 1 3 7 8
Distance between 3 and 7: 0.130615
Distance < 0.284
list of signs after deletion: 1 3 8
Distance between 3 and 8: 0.130615
Distance < 0.284
list of signs after deletion: 1 3

So, there are 2 school zones with the following representative signs:
1 3

Step 2
Check all the other school zones (only zone 3 in this case) to see if they are within the specified radius (10 miles) of school zone 1
Distance between 1 and 1: 0
Updated list of schools within radius: Null
Distance between 1 and 3: 1.73759
Distance < 10
Updated list of schools within radius: 3

Then, the following attributes of school zone 1 are calculated -

Sign No.	longitude	latitude	Density_no	Density_persqmile	Far_dist	Near_dist	Avg_dist
1	-91.3793	31.5122	1	0.0032	1.74	1.74	1.74

Check all the other signs to see if they are within the radius of school zone 3

Distance between 3 and 3: 0
Updated list of schools within radius: 1

Then, the following attributes of school zone 3 are calculated -

Sign No.	longitude	latitude	Density_no	Density_persqmile	Far_dist	Near_dist	Avg_dist
3	-91.3782	31.5373	1	0.0032	1.74	1.74	1.74

Appendix B: Sign Saturation Data

Table B1. Sign saturation data for all school zones within the State of Mississippi

School Zone #	Location		Density number	Density per sq-mile	Farthest distance	Nearest distance	Average distance
	Latitude	Longitude					
1	31.0025	-90.4746	2	0.0064	9.90	0.52	5.21
2	31.0094	-90.4710	2	0.0064	9.41	0.52	4.96
3	31.1453	-90.4611	5	0.0160	9.90	0.91	5.65
4	31.1573	-90.4547	4	0.0130	9.39	0.91	4.19
5	31.1823	-90.4505	6	0.0190	9.88	1.75	5.76
6	31.2007	-88.9964	3	0.0095	4.95	0.62	3.36
7	31.2775	-90.3378	4	0.0130	9.36	0.52	6.97
8	31.1608	-88.9269	4	0.0130	6.58	0.44	4.10
9	31.1997	-88.9861	3	0.0095	4.41	0.62	3.00
10	31.2824	-90.3311	4	0.0130	9.88	0.52	7.32
11	31.5113	-91.3781	5	0.0160	3.95	1.87	2.97
12	31.5383	-91.3777	5	0.0160	2.09	0.43	1.53
13	31.5443	-91.3756	5	0.0160	2.28	0.43	1.37
14	31.5547	-91.3681	5	0.0160	3.06	0.79	1.39
15	31.5619	-91.3577	5	0.0160	3.70	0.79	1.82
16	31.5683	-91.3732	5	0.0160	3.95	0.99	1.95
17	31.1521	-90.7974	1	0.0032	0.55	0.55	0.55
18	31.1994	-91.0109	4	0.0130	9.54	8.55	9.09
19	33.1254	-89.4654	6	0.0190	8.17	1.16	6.08
20	33.1398	-89.4550	6	0.0190	9.20	1.16	6.97
21	34.8661	-88.4194	7	0.0220	9.86	0.64	6.52
22	34.8623	-88.4092	8	0.0250	9.65	0.64	6.74
23	34.8727	-88.6444	2	0.0064	9.21	5.44	7.33
24	31.0822	-91.0571	4	0.0130	8.55	0.57	3.03
25	33.0500	-89.6205	7	0.0220	9.13	2.26	4.47
26	34.9064	-88.4872	4	0.0130	9.21	4.75	6.41
27	33.0220	-89.6909	6	0.0190	7.45	4.51	6.23
28	31.1593	-90.8013	1	0.0032	0.55	0.55	0.55
29	33.0982	-89.5119	7	0.0220	7.12	3.29	4.82
30	33.0716	-89.5912	8	0.0250	9.18	0.43	4.43
31	33.0486	-89.5707	8	0.0250	9.20	0.45	4.52
32	33.0548	-89.5684	8	0.0250	8.81	0.45	4.37
33	33.0034	-89.7681	6	0.0190	9.13	4.65	7.59
34	34.1933	-90.5686	3	0.0095	4.33	0.74	2.94
35	34.1969	-90.5564	3	0.0095	3.59	0.74	2.44
36	33.8411	-90.7249	8	0.0250	9.34	0.59	5.69

Table B1. Sign saturation data for all school zones within the State of Mississippi (Continued)

School Zone #	Location		Density number	Density per sq-mile	Farthest distance	Nearest distance	Average distance
	Latitude	Longitude					
37	33.8774	-90.7274	7	0.0220	9.86	1.93	7.13
38	33.8557	-91.0277	3	0.0095	1.40	0.47	0.93
39	33.6345	-91.0289	0	0.0000	N/A	N/A	N/A.00
40	33.8359	-91.0228	3	0.0095	1.40	0.52	0.95
41	33.8424	-91.0272	3	0.0095	0.92	0.45	0.63
42	33.8489	-91.0276	3	0.0095	0.94	0.45	0.62
43	33.8496	-90.7253	8	0.0250	9.92	0.59	6.05
44	32.0366	-88.7247	2	0.0064	3.15	1.26	2.21
45	34.2143	-90.5083	3	0.0095	3.74	0.62	2.45
46	34.2153	-90.4976	3	0.0095	4.33	0.62	2.85
47	32.1685	-88.8086	5	0.0160	9.16	0.50	5.12
48	32.0545	-88.7287	5	0.0160	9.97	1.26	6.39
49	32.1755	-88.8104	5	0.0160	9.63	0.50	5.22
50	32.1759	-88.8208	5	0.0160	9.97	0.61	5.55
51	31.5622	-89.5009	2	0.0064	9.96	9.90	9.93
52	31.8740	-90.1600	1	0.0032	4.31	4.31	4.31
53	31.7285	-89.4476	1	0.0032	7.10	7.10	7.10
54	31.9345	-90.3883	0	0.0000	N/A	N/A	N/A
55	33.7581	-89.8082	0	0.0000	N/A	N/A	N/A
56	34.8368	-88.5590	4	0.0130	8.67	5.44	7.15
57	31.1410	-88.6103	2	0.0064	3.48	0.65	2.07
58	31.1451	-88.6004	2	0.0064	2.84	0.65	1.75
59	31.3476	-88.7628	0	0.0000	N/A	N/A	N/A
60	31.1121	-88.8312	2	0.0064	7.02	6.58	6.80
61	30.3734	-89.4323	2	0.0064	8.98	6.70	7.84
62	30.5033	-89.4340	1	0.0032	8.98	8.98	8.98
63	31.1550	-88.5537	2	0.0064	3.48	2.84	3.16
64	30.2537	-89.6149	0	0.0000	N/A	N/A	N/A
65	33.7061	-90.7191	9	0.0290	9.92	2.01	5.44
66	33.7351	-90.7159	11	0.0350	9.86	0.94	5.65
67	33.0673	-89.5858	8	0.0250	9.08	0.43	4.30
68	30.3193	-89.3390	1	0.0032	6.70	6.70	6.70
69	33.7556	-90.7664	9	0.0290	9.82	1.51	5.07
70	33.7485	-90.7415	10	0.0320	9.87	0.60	5.00
71	33.7477	-90.7311	10	0.0320	9.92	0.55	4.93
72	33.9914	-89.3419	1	0.0032	5.56	5.56	5.56
73	33.7478	-90.7216	9	0.0290	9.62	0.55	4.47
74	33.6070	-90.7652	5	0.0160	9.92	0.45	7.37

Table B1. Sign saturation data for all school zones within the State of Mississippi (Continued)

School Zone #	Location		Density number	Density per sq-mile	Farthest distance	Nearest distance	Average distance
	Latitude	Longitude					
75	33.6134	-90.7656	7	0.0220	9.82	0.45	7.80
76	34.0383	-89.0175	1	0.0032	9.85	9.85	9.85
77	33.8768	-89.1679	2	0.0064	9.85	9.34	9.59
78	33.9121	-89.3251	2	0.0064	9.34	5.56	7.45
79	30.3699	-89.0929	2	0.0064	5.38	4.18	4.78
80	30.5148	-89.1083	7	0.0220	9.84	4.68	7.34
81	31.9510	-90.9859	2	0.0064	2.30	1.79	2.05
82	34.0183	-88.7550	7	0.0220	9.39	0.53	6.12
83	30.3908	-89.0270	5	0.0160	9.85	4.18	7.79
84	33.2932	-89.4021	0	0.0000	N/A	N/A	N/A
85	33.3070	-89.1763	2	0.0064	7.36	0.51	3.94
86	34.0025	-88.7553	6	0.0190	9.75	0.55	6.19
87	34.0105	-88.7553	7	0.0220	9.72	0.53	6.35
88	33.8966	-88.9979	2	0.0064	9.85	9.85	9.85
89	33.3098	-89.1681	2	0.0064	6.85	0.51	3.68
90	32.4505	-90.1928	13	0.0410	9.37	2.46	5.51
91	32.3630	-90.2386	13	0.0410	9.85	0.97	7.12
92	33.3104	-90.0197	0	0.0000	N/A	N/A	N/A
93	32.0822	-88.7257	6	0.0190	9.88	1.92	6.55
94	32.2234	-88.7002	4	0.0130	9.88	7.24	8.07
95	31.9654	-90.9605	2	0.0064	1.79	0.56	1.18
96	31.9662	-90.9509	2	0.0064	2.30	0.56	1.43
97	30.6291	-89.1322	3	0.0095	8.77	0.45	5.75
98	30.4476	-89.0989	6	0.0190	8.69	4.68	6.90
99	30.5178	-88.9779	5	0.0160	9.25	1.31	6.05
100	30.5305	-88.9942	5	0.0160	9.85	1.31	5.68
101	30.5478	-89.0191	6	0.0190	9.01	1.90	6.18
102	30.6356	-89.1311	3	0.0095	9.01	0.45	5.97
103	32.3286	-90.6062	0	0.0000	N/A	N/A	N/A
104	32.2454	-90.4339	7	0.0220	8.67	0.54	5.06
105	32.2469	-90.4232	7	0.0220	8.16	0.55	4.74
106	32.2688	-90.3054	10	0.0320	8.28	0.65	6.35
107	32.2687	-90.2943	10	0.0320	8.84	0.65	6.58
108	32.2497	-90.4143	7	0.0220	7.67	0.55	4.60
109	32.1052	-90.6140	0	0.0000	N/A	N/A	N/A
110	32.2423	-90.4423	7	0.0220	9.18	0.54	5.51
111	33.1683	-90.1876	1	0.0032	8.59	8.59	8.59

Table B1. Sign saturation data for all school zones within the State of Mississippi (Continued)

School Zone #	Location		Density number	Density per sq-mile	Farthest distance	Nearest distance	Average distance
	Latitude	Longitude					
112	34.9437	-90.1541	3	0.0095	7.07	0.68	2.91
113	34.9505	-90.1453	3	0.0095	6.51	0.53	2.57
114	32.3827	-90.2611	11	0.0350	9.85	0.93	6.60
115	32.3730	-90.2502	12	0.0380	9.90	0.93	6.78
116	31.2825	-89.2946	6	0.0190	9.26	0.43	4.98
117	31.2872	-89.2994	7	0.0220	9.92	0.43	5.55
118	31.2944	-89.3052	7	0.0220	9.60	0.61	5.49
119	34.9626	-90.0314	4	0.0130	7.07	6.51	6.74
120	34.9574	-90.1494	3	0.0095	6.69	0.53	2.73
121	34.9623	-89.9133	1	0.0032	6.68	6.68	6.68
122	33.1162	-90.0529	1	0.0032	8.59	8.59	8.59
123	30.8801	-88.6574	7	0.0220	9.39	4.07	7.00
124	30.8202	-88.5180	5	0.0160	9.24	0.45	6.90
125	30.9108	-88.5988	5	0.0160	8.20	0.76	4.38
126	31.4522	-90.8582	0	0.0000	N/A	N/A	N/A
127	30.9204	-88.5928	5	0.0160	8.57	0.51	4.56
128	30.8137	-88.5192	5	0.0160	9.39	0.45	7.13
129	30.8718	-88.8052	2	0.0064	8.78	0.66	4.72
130	30.8741	-88.7945	2	0.0064	8.14	0.66	4.40
131	31.3468	-89.2619	6	0.0190	9.17	3.10	5.01
132	31.3504	-89.2097	6	0.0190	6.86	0.76	5.09
133	31.3506	-89.1969	6	0.0190	7.48	0.76	5.40
134	30.9253	-88.5992	5	0.0160	9.05	0.51	4.78
135	33.1658	-90.4988	1	0.0032	1.63	1.63	1.63
136	34.2742	-88.4156	6	0.0190	9.18	3.32	7.00
137	32.9722	-89.9153	5	0.0160	8.80	3.41	7.29
138	33.0898	-89.8655	4	0.0130	8.62	0.51	4.77
139	33.0870	-89.8573	4	0.0130	8.61	0.51	4.62
140	30.5192	-88.6918	5	0.0160	9.31	0.61	4.43
141	30.5276	-88.6888	5	0.0160	9.88	0.61	4.42
142	30.5406	-88.6876	3	0.0095	1.50	0.44	0.95
143	30.5466	-88.6902	3	0.0095	1.90	0.44	1.22
144	32.9270	-89.9390	1	0.0032	3.41	3.41	3.41
145	33.1880	-90.4895	1	0.0032	1.63	1.63	1.63
146	33.0644	-89.8645	4	0.0130	7.01	1.62	4.35
147	30.3930	-88.5086	7	0.0220	6.85	0.99	3.48
148	30.4073	-88.5106	7	0.0220	6.88	0.99	3.38
149	30.4376	-88.5445	7	0.0220	5.89	1.74	3.88

Table B1. Sign saturation data for all school zones within the State of Mississippi (Continued)

School Zone #	Location		Density number	Density per sq-mile	Farthest distance	Nearest distance	Average distance
	Latitude	Longitude					
150	34.2232	-88.3925	3	0.0095	7.80	0.45	4.01
151	34.2288	-88.3965	3	0.0095	7.96	0.45	3.91
152	34.2455	-88.2586	5	0.0160	9.18	7.80	8.53
153	30.6507	-88.5335	1	0.0032	1.89	1.89	1.89
154	30.6540	-88.5020	1	0.0032	1.89	1.89	1.89
155	30.3747	-88.5455	7	0.0220	4.71	1.45	3.26
156	30.3945	-88.5371	7	0.0220	5.17	1.27	2.71
157	30.4128	-88.5393	7	0.0220	5.34	1.27	2.83
158	34.3599	-88.3189	3	0.0095	8.62	0.58	5.76
159	34.3682	-88.3171	3	0.0095	9.11	0.58	6.09
160	30.4139	-88.7893	3	0.0095	9.88	1.20	6.80
161	31.5964	-89.1968	8	0.0250	8.64	1.58	5.08
162	31.7526	-89.1538	10	0.0320	9.94	4.05	7.08
163	31.7037	-91.0771	1	0.0032	0.65	0.65	0.65
164	30.3839	-88.6125	8	0.0250	9.54	0.66	5.20
165	31.6987	-89.0546	6	0.0190	6.93	0.82	4.96
166	30.4105	-88.7697	5	0.0160	9.54	1.20	7.57
167	31.9734	-89.3157	2	0.0064	2.30	1.84	2.07
168	30.3861	-88.6234	8	0.0250	8.88	0.66	5.55
169	31.6944	-91.0753	1	0.0032	0.65	0.65	0.65
170	31.6238	-89.2149	9	0.0290	9.78	0.59	5.05
171	31.6166	-89.2093	9	0.0290	9.94	0.59	5.07
172	31.7851	-89.0964	6	0.0190	9.24	0.48	5.96
173	31.7007	-89.0408	6	0.0190	7.55	0.82	5.37
174	32.7749	-88.6463	2	0.0064	1.69	1.20	1.44
175	31.7917	-89.0987	6	0.0190	9.69	0.48	6.29
176	31.6111	-89.2205	8	0.0250	8.84	0.76	4.67
177	32.8310	-88.4606	0	0.0000	N/A	N/A	N/A
178	31.6824	-89.2465	8	0.0250	8.63	0.80	5.79
179	32.7767	-88.6668	2	0.0064	1.20	0.49	0.85
180	31.6858	-89.2335	8	0.0250	7.95	0.80	5.52
181	32.7771	-88.6753	2	0.0064	1.69	0.49	1.09
182	31.2818	-89.4672	4	0.0130	9.93	2.59	8.01
183	31.4193	-89.5389	3	0.0095	9.03	0.92	3.77
184	31.0964	-89.4141	3	0.0095	7.34	2.32	4.16
185	32.3333	-90.3279	10	0.0320	9.18	0.56	5.98

Table B1. Sign saturation data for all school zones within the State of Mississippi (Continued)

School Zone #	Location		Density number	Density per sq-mile	Farthest distance	Nearest distance	Average distance
	Latitude	Longitude					
186	31.4193	-89.5232	4	0.0130	9.96	0.45	4.96
187	31.4195	-89.5156	5	0.0160	9.93	0.45	5.99
188	31.3150	-89.4467	7	0.0220	9.26	2.59	7.86
189	32.3356	-90.3371	10	0.0320	8.91	0.56	6.07
190	31.0825	-89.5879	1	0.0032	9.89	9.89	9.89
191	32.3248	-88.5609	5	0.0160	9.95	0.59	6.71
192	32.3290	-88.5696	6	0.0190	9.96	0.59	6.90
193	32.4666	-88.6735	8	0.0250	7.63	0.58	3.63
194	32.4748	-88.6758	8	0.0250	7.15	0.58	3.98
195	32.4449	-88.6711	9	0.0290	9.96	0.59	3.98
196	32.4535	-88.6715	8	0.0250	8.34	0.59	3.30
197	32.5406	-88.7706	5	0.0160	9.35	7.15	8.25
198	31.4029	-90.1461	1	0.0032	0.47	0.47	0.47
199	31.5793	-90.1302	1	0.0032	1.38	1.38	1.38
200	31.5597	-90.1261	1	0.0032	1.38	1.38	1.38
201	31.4096	-90.1470	1	0.0032	0.47	0.47	0.47
202	32.4322	-88.6745	10	0.0320	9.95	0.90	4.64
203	32.4031	-88.5957	9	0.0290	6.81	4.89	5.59
204	32.4115	-88.6788	9	0.0290	9.12	1.46	4.39
205	32.3821	-88.6828	9	0.0290	8.14	2.04	5.35
206	32.6810	-89.4510	5	0.0160	7.94	0.46	5.50
207	32.6784	-89.4437	6	0.0190	9.72	0.46	6.35
208	32.7283	-89.5469	4	0.0130	6.92	1.23	4.34
209	34.2630	-88.7158	11	0.0350	9.79	1.28	5.71
210	34.1214	-88.7123	14	0.0450	9.79	0.45	6.94
211	34.1996	-88.7200	12	0.0380	9.57	3.40	5.84
212	31.7287	-89.9837	0	0.0000	N/A	N/A	N/A
213	32.8544	-89.6571	1	0.0032	9.03	9.03	9.03
214	34.4469	-88.6658	3	0.0095	5.24	4.33	4.67
215	31.6515	-89.1044	12	0.0380	9.69	0.45	6.70
216	31.6573	-89.1077	12	0.0380	9.30	0.45	6.52
217	31.4939	-89.2810	4	0.0130	9.78	8.64	9.18
218	34.2668	-88.5734	7	0.0220	9.97	6.12	8.39
219	34.1244	-88.7193	14	0.0450	9.58	0.45	6.95
220	32.7677	-89.5407	5	0.0160	9.03	1.61	5.94
221	31.5398	-89.8053	4	0.0130	5.65	0.56	3.85
222	31.5381	-89.7960	4	0.0130	6.10	0.56	3.73

Table B1. Sign saturation data for all school zones within the State of Mississippi (Continued)

School Zone #	Location		Density number	Density per sq-mile	Farthest distance	Nearest distance	Average distance
	Latitude	Longitude					
223	32.6807	-89.3489	3	0.0095	7.78	5.51	6.41
224	32.7445	-89.5380	4	0.0130	7.14	1.23	4.17
225	33.8255	-88.5476	4	0.0130	8.83	0.86	6.28
226	34.0891	-88.6208	9	0.0290	9.75	0.62	6.92
227	34.0719	-88.3887	0	0.0000	N/A	N/A	N/A
228	33.8300	-88.5616	4	0.0130	9.63	0.86	6.35
229	31.6023	-89.8671	2	0.0064	6.10	5.65	5.88
230	31.9861	-89.2882	2	0.0064	1.84	0.74	1.29
231	34.2575	-88.6800	11	0.0350	9.58	2.07	5.99
232	31.9805	-89.2774	2	0.0064	2.30	0.74	1.52
233	31.4977	-89.7493	3	0.0095	4.39	0.43	2.91
234	31.4949	-89.7428	3	0.0095	4.81	0.43	3.19
235	34.3883	-88.6924	8	0.0250	9.73	0.54	7.59
236	34.3673	-89.5218	3	0.0095	2.39	1.78	2.01
237	34.3857	-89.4979	3	0.0095	3.77	1.87	2.65
238	33.7373	-88.4363	2	0.0064	9.63	8.83	9.23
239	34.1098	-88.6817	9	0.0290	8.52	1.92	5.44
240	33.9356	-88.4827	2	0.0064	8.58	8.47	8.53
241	33.7967	-88.6641	2	0.0064	6.98	6.32	6.65
242	33.4757	-89.7355	2	0.0064	9.15	0.99	5.07
243	32.7049	-89.0514	4	0.0130	9.89	0.49	5.77
244	32.7105	-89.0563	3	0.0095	7.27	0.49	4.09
245	33.4613	-89.7362	2	0.0064	8.15	0.99	4.57
246	34.3332	-89.5154	3	0.0095	3.77	1.68	2.61
247	34.3520	-89.4968	3	0.0095	2.33	1.68	1.93
248	31.1364	-89.4054	2	0.0064	2.81	0.49	1.65
249	31.1294	-89.4066	3	0.0095	9.64	0.49	4.15
250	30.9961	-89.4548	3	0.0095	9.89	7.34	8.96
251	34.6573	-89.5656	1	0.0032	0.43	0.43	0.43
252	33.3436	-89.7457	2	0.0064	9.15	8.15	8.65
253	32.5727	-89.1168	3	0.0095	9.89	7.29	8.68
254	34.4830	-88.9990	6	0.0190	9.51	0.54	7.45
255	32.8332	-88.9367	0	0.0000	N/A	N/A	N/A
256	32.7561	-89.1691	3	0.0095	7.71	4.52	6.50
257	32.4447	-89.1085	6	0.0190	9.47	1.23	4.04
258	32.4674	-89.1101	6	0.0190	9.39	1.57	4.53
259	32.7680	-89.0926	3	0.0095	4.98	4.50	4.67

Table B1. Sign saturation data for all school zones within the State of Mississippi (Continued)

School Zone #	Location		Density number	Density per sq-mile	Farthest distance	Nearest distance	Average distance
	Latitude	Longitude					
260	32.4268	-89.1099	5	0.0160	9.55	0.78	3.05
261	32.4545	-89.2704	6	0.0190	9.55	8.17	9.10
262	34.6802	-90.3761	4	0.0130	7.88	1.42	4.69
263	34.1994	-90.2865	2	0.0064	3.26	2.62	2.94
264	34.8366	-88.3184	7	0.0220	7.19	0.51	4.41
265	34.8326	-88.3110	7	0.0220	6.71	0.51	4.27
266	34.7824	-90.3379	4	0.0130	7.39	0.49	4.83
267	34.7889	-90.3342	4	0.0130	7.88	0.49	5.20
268	34.8075	-88.2658	7	0.0220	9.61	0.55	4.36
269	34.7007	-90.3755	4	0.0130	6.53	0.66	3.66
270	34.8060	-88.2534	6	0.0190	9.65	0.53	3.70
271	34.7102	-90.3749	4	0.0130	5.91	0.66	3.51
272	34.2369	-90.2793	2	0.0064	2.62	0.63	1.63
273	34.2458	-90.2763	2	0.0064	3.26	0.63	1.94
274	34.5559	-89.1178	5	0.0160	9.09	6.70	7.87
275	34.6532	-88.2293	2	0.0064	9.77	7.60	8.68
276	34.4903	-88.9957	6	0.0190	9.77	0.54	7.65
277	32.3614	-89.4745	3	0.0095	8.57	6.47	7.26
278	34.7286	-88.9463	4	0.0130	8.37	0.45	5.74
279	34.6014	-89.9685	3	0.0095	9.70	5.50	7.11
280	34.8391	-88.9382	5	0.0160	7.65	0.77	6.20
281	34.5125	-88.2119	2	0.0064	9.77	2.20	5.98
282	34.5433	-88.2222	2	0.0064	7.60	2.20	4.90
283	34.6122	-90.1514	0	0.0000	N/A	N/A	N/A
284	34.7297	-88.9385	4	0.0130	8.26	0.45	5.79
285	34.9442	-88.9021	3	0.0095	7.55	1.90	5.41
286	32.3470	-89.3287	3	0.0095	9.19	8.17	8.65
287	34.6807	-89.9780	3	0.0095	9.70	0.61	5.27
288	34.8101	-88.1958	5	0.0160	7.19	3.28	4.94
289	34.9326	-88.8717	3	0.0095	7.48	1.90	5.36
290	34.6680	-89.0340	3	0.0095	9.09	6.51	7.50
291	34.8124	-88.2583	7	0.0220	9.86	0.53	4.40
292	34.6896	-89.9785	3	0.0095	9.86	0.61	5.53
293	34.2501	-88.7655	8	0.0250	9.40	1.09	5.03
294	34.2550	-88.7474	11	0.0350	9.97	0.63	5.96
295	31.5786	-90.4388	7	0.0220	9.91	1.24	7.38
296	34.2559	-88.7365	11	0.0350	9.49	0.63	5.75

Table B1. Sign saturation data for all school zones within the State of Mississippi (Continued)

School Zone #	Location		Density number	Density per sq-mile	Farthest distance	Nearest distance	Average distance
	Latitude	Longitude					
297	33.7547	-90.3088	0	0.0000	N/A	N/A	N/A
298	31.5888	-90.4562	5	0.0160	9.23	1.24	6.41
299	33.5101	-90.1504	3	0.0095	6.15	0.73	3.76
300	33.5298	-90.2546	5	0.0160	6.15	4.87	5.45
301	34.8492	-88.9323	5	0.0160	8.37	0.77	6.18
302	31.4362	-90.4593	4	0.0130	9.91	0.49	5.12
303	31.4431	-90.4577	4	0.0130	9.42	0.49	4.85
304	33.5045	-90.3418	3	0.0095	7.97	1.56	4.95
305	34.0980	-88.6223	8	0.0250	9.72	0.62	6.39
306	33.5014	-90.1576	4	0.0130	9.67	0.73	5.01
307	33.4871	-90.3245	4	0.0130	9.67	1.56	5.73
308	31.4703	-90.3839	5	0.0160	9.23	0.43	5.51
309	33.5667	-88.3597	0	0.0000	N/A	N/A	N/A
310	33.4700	-90.2099	5	0.0160	7.97	3.72	5.53
311	34.3896	-88.7018	8	0.0250	9.68	0.54	7.56
312	34.2045	-88.6608	12	0.0380	8.29	3.40	6.07
313	33.4780	-88.5022	0	0.0000	N/A	N/A	N/A
314	32.4726	-90.1437	11	0.0350	9.39	1.20	4.60
315	32.4541	-90.1150	15	0.0480	9.85	0.60	6.45
316	32.4633	-90.1105	12	0.0380	9.94	0.43	5.67
317	32.4805	-90.1620	13	0.0410	9.60	0.66	5.28
318	32.4821	-90.1732	13	0.0410	9.07	0.66	5.24
319	32.7345	-89.8325	3	0.0095	4.82	0.49	3.33
320	32.7390	-89.8261	3	0.0095	5.11	0.49	3.51
321	32.5331	-90.1922	11	0.0350	9.71	0.55	5.66
322	32.5387	-90.1991	11	0.0350	9.85	0.55	5.92
323	32.4626	-90.1178	12	0.0380	9.90	0.43	5.53
324	31.4758	-90.3871	5	0.0160	8.80	0.43	5.35
325	32.6116	-90.0538	5	0.0160	9.85	0.61	5.49
326	32.6127	-90.0434	3	0.0095	3.24	0.61	2.23
327	32.6223	-89.9958	3	0.0095	3.46	0.45	2.25
328	31.6283	-90.5587	3	0.0095	7.85	0.48	4.98
329	31.6268	-90.5507	3	0.0095	7.38	0.48	4.67
330	32.6270	-89.9904	3	0.0095	3.84	0.45	2.51
331	34.9559	-89.5160	1	0.0032	1.71	1.71	1.71
332	34.8752	-89.6886	1	0.0032	0.51	0.51	0.51
333	34.8825	-89.6888	1	0.0032	0.51	0.51	0.51

Table B1. Sign saturation data for all school zones within the State of Mississippi (Continued)

School Zone #	Location		Density number	Density per sq-mile	Farthest distance	Nearest distance	Average distance
	Latitude	Longitude					
334	34.6522	-89.3097	0	0.0000	N/A	N/A	N/A
335	34.6572	-89.5732	1	0.0032	0.43	0.43	0.43
336	31.2540	-89.7820	5	0.0160	7.23	2.12	4.55
337	31.2896	-89.7691	5	0.0160	9.02	2.58	5.96
338	32.5452	-90.3079	8	0.0250	9.60	0.46	7.34
339	32.5459	-90.3001	8	0.0250	9.23	0.46	7.17
340	32.6652	-89.8226	3	0.0095	5.11	0.50	3.48
341	32.6683	-89.8148	3	0.0095	4.93	0.50	3.37
342	32.4216	-89.0959	4	0.0130	3.27	0.44	1.59
343	32.4280	-89.0967	4	0.0130	2.83	0.44	1.35
344	33.4658	-88.8216	1	0.0032	0.61	0.61	0.61
345	33.4724	-88.8145	1	0.0032	0.61	0.61	0.61
346	31.2339	-89.8666	5	0.0160	6.93	0.47	3.56
347	31.2184	-89.8970	5	0.0160	9.02	1.69	5.04
348	31.2503	-89.8177	5	0.0160	5.18	2.12	3.58
349	31.2337	-89.8746	5	0.0160	7.33	0.47	3.74
350	33.1684	-90.8562	1	0.0032	7.18	7.18	7.18
351	33.2257	-91.0498	2	0.0064	9.23	0.66	4.95
352	33.2349	-91.0464	3	0.0095	9.75	0.66	6.33
353	32.2932	-90.8953	5	0.0160	6.99	0.60	4.87
354	33.2699	-90.8829	2	0.0064	9.75	7.18	8.46
355	32.3693	-90.8277	5	0.0160	7.17	0.52	3.86
356	32.3768	-90.8278	5	0.0160	7.59	0.52	4.24
357	33.3443	-89.0569	2	0.0064	7.36	6.85	7.11
358	34.9565	-89.4858	1	0.0032	1.71	1.71	1.71
359	34.5179	-88.6333	4	0.0130	9.92	5.24	8.60
360	34.6419	-88.4858	5	0.0160	6.96	1.68	4.85
361	34.6306	-88.4597	5	0.0160	8.49	0.54	4.26
362	34.6278	-88.4508	5	0.0160	9.03	0.54	4.32
363	32.3294	-90.8185	5	0.0160	5.68	0.66	3.52
364	32.3369	-90.8255	5	0.0160	5.65	0.66	3.28
365	32.2864	-90.9015	5	0.0160	7.59	0.60	5.34
366	31.2225	-90.4772	6	0.0190	9.58	3.19	6.11
367	33.4038	-91.0377	7	0.0220	3.09	0.44	1.17
368	33.4115	-91.0377	7	0.0220	3.62	0.49	1.33
369	33.3591	-91.0408	9	0.0290	9.23	2.80	4.52
370	33.4063	-91.0619	7	0.0220	3.47	0.62	1.61

Table B1. Sign saturation data for all school zones within the State of Mississippi (Continued)

School Zone #	Location		Density number	Density per sq-mile	Farthest distance	Nearest distance	Average distance
	Latitude	Longitude					
371	33.4185	-91.0383	7	0.0220	4.11	0.49	1.67
372	34.7097	-88.6694	1	0.0032	5.05	5.05	5.05
373	31.8761	-89.7313	2	0.0064	5.69	5.24	5.46
374	30.5134	-89.6833	4	0.0130	7.66	1.92	3.54
375	34.2976	-90.0037	2	0.0064	6.80	4.00	5.40
376	30.6212	-89.6534	3	0.0095	9.72	5.76	7.71
377	30.5394	-89.6718	4	0.0130	5.76	1.92	4.02
378	33.8092	-90.5240	3	0.0095	5.89	3.03	4.79
379	30.4780	-89.6923	3	0.0095	4.41	0.44	2.45
380	30.4844	-89.6911	4	0.0130	9.72	0.44	4.05
381	33.4405	-90.5057	4	0.0130	7.90	0.46	5.94
382	33.4471	-90.5054	4	0.0130	8.28	0.46	5.91
383	33.5480	-90.5311	3	0.0095	8.83	7.13	7.84
384	33.3503	-90.5900	3	0.0095	8.28	7.90	8.05
385	30.8276	-89.5234	1	0.0032	0.58	0.58	0.58
386	30.8341	-89.5295	1	0.0032	0.58	0.58	0.58
387	33.7261	-90.5468	4	0.0130	9.73	0.49	4.74
388	33.7665	-90.5359	3	0.0095	3.03	2.43	2.77
389	33.9703	-90.2361	2	0.0064	7.72	6.79	7.26
390	31.9186	-89.8054	2	0.0064	5.24	0.45	2.84
391	32.0382	-89.5254	2	0.0064	3.35	2.85	3.10
392	34.0123	-90.4269	2	0.0064	6.28	4.73	5.50
393	33.7316	-90.5416	3	0.0095	5.45	0.49	2.79
394	33.9466	-90.3512	3	0.0095	6.79	1.55	4.88
395	31.9219	-89.8119	2	0.0064	5.69	0.45	3.07
396	33.9623	-90.3706	3	0.0095	7.72	1.55	4.67
397	33.4579	-90.6398	4	0.0130	8.83	7.78	8.10
398	34.6542	-89.8103	3	0.0095	9.86	9.70	9.76
399	32.4902	-89.8693	1	0.0032	0.60	0.60	0.60
400	32.2679	-89.9892	9	0.0290	7.24	1.08	6.11
401	32.4817	-89.8671	3	0.0095	9.95	0.60	6.72
402	32.3587	-90.0092	12	0.0380	9.57	0.69	5.31
403	32.3676	-89.9850	11	0.0350	9.87	0.51	5.01
404	32.3724	-89.9784	12	0.0380	9.95	0.51	5.64
405	32.3612	-89.9977	12	0.0380	9.90	0.69	5.28
406	32.0872	-89.7826	1	0.0032	0.47	0.47	0.47
407	32.3066	-89.8028	3	0.0095	9.19	0.66	3.69

Table B1. Sign saturation data for all school zones within the State of Mississippi (Continued)

School Zone #	Location		Density number	Density per sq-mile	Farthest distance	Nearest distance	Average distance
	Latitude	Longitude					
408	32.0823	-89.7772	1	0.0032	0.47	0.47	0.47
409	33.1051	-88.5593	3	0.0095	9.29	0.59	5.74
410	31.8297	-89.4266	2	0.0064	7.75	7.10	7.42
411	31.8595	-89.5538	3	0.0095	9.72	7.75	8.90
412	31.9900	-89.5200	3	0.0095	9.23	0.50	4.36
413	31.9972	-89.5206	3	0.0095	9.72	0.50	4.36
414	30.8518	-89.1347	2	0.0064	1.71	1.15	1.43
415	32.9990	-88.5632	2	0.0064	7.44	7.33	7.39
416	30.8460	-89.1166	2	0.0064	1.15	0.57	0.86
417	30.8445	-89.1072	2	0.0064	1.71	0.57	1.14
418	31.0744	-89.9977	2	0.0064	9.16	9.09	9.12
419	34.4405	-88.8413	4	0.0130	9.45	8.70	9.20
420	31.1263	-90.1401	2	0.0064	9.16	1.50	5.33
421	33.2378	-88.5335	2	0.0064	9.29	9.15	9.22
422	33.1060	-88.5492	3	0.0095	9.15	0.59	5.73
423	31.1054	-90.1469	2	0.0064	9.09	1.50	5.29
424	31.2901	-90.4882	5	0.0160	9.39	4.72	8.02
425	34.2334	-89.1004	7	0.0220	9.66	0.46	5.77
426	34.3606	-89.0300	9	0.0290	9.66	0.50	7.27
427	34.3675	-89.0276	8	0.0250	8.68	0.50	7.11
428	34.2292	-89.1066	6	0.0190	7.84	0.46	5.47
429	34.2730	-89.0231	8	0.0250	6.54	1.42	4.09
430	34.6596	-88.6049	5	0.0160	9.92	5.05	7.87
431	34.4689	-89.1742	2	0.0064	6.81	0.54	3.68
432	34.4670	-89.1649	4	0.0130	9.77	0.54	6.63
433	31.3493	-88.9436	0	0.0000	N/A	N/A	N/A
434	31.3758	-89.1103	3	0.0095	9.17	5.40	6.90
435	34.2527	-88.9723	8	0.0250	8.54	0.74	5.00
436	34.2507	-88.9997	8	0.0250	8.23	0.83	4.19
437	34.2535	-89.0154	8	0.0250	7.91	0.92	4.05
438	34.5644	-88.4204	4	0.0130	6.52	0.47	4.20
439	34.5608	-88.4134	4	0.0130	6.96	0.47	4.51
440	34.2516	-88.9851	8	0.0250	8.37	0.74	4.51
441	31.8807	-90.0870	1	0.0032	4.31	4.31	4.31
442	34.2147	-89.9393	2	0.0064	7.60	6.80	7.20
443	34.3247	-89.9418	3	0.0095	8.01	4.00	6.54
444	34.4399	-89.9261	1	0.0032	8.01	8.01	8.01

Table B1. Sign saturation data for all school zones within the State of Mississippi (Continued)

School Zone #	Location		Density number	Density per sq-mile	Farthest distance	Nearest distance	Average distance
	Latitude	Longitude					
445	31.1647	-88.9329	4	0.0130	7.02	0.44	3.99
446	32.9704	-90.8238	0	0.0000	N/A	N/A	N/A
447	32.4546	-89.4841	2	0.0064	6.47	3.31	4.89
448	32.4507	-89.4275	5	0.0160	9.60	3.31	7.61
449	32.3473	-89.6529	3	0.0095	9.19	8.03	8.62
450	32.5684	-89.3398	4	0.0130	9.72	7.78	8.99
451	32.1627	-90.1074	4	0.0130	8.38	0.45	4.65
452	33.6203	-89.0836	1	0.0032	5.80	5.80	5.80
453	31.6793	-88.6403	4	0.0130	9.60	0.64	3.00
454	31.6858	-88.6327	3	0.0095	0.95	0.64	0.80
455	33.3996	-91.0321	7	0.0220	2.84	0.44	1.36
456	32.3602	-89.9717	9	0.0290	9.54	0.79	4.09
457	32.3703	-89.9656	9	0.0290	9.65	0.76	4.45
458	32.1532	-90.1284	4	0.0130	9.21	0.97	5.17
459	32.2830	-89.9940	9	0.0290	6.65	1.08	5.35
460	32.1581	-90.1129	4	0.0130	8.73	0.45	4.71
461	32.2837	-90.1077	12	0.0380	9.73	0.74	7.88
462	32.2835	-90.0950	12	0.0380	9.65	0.74	7.56
463	32.3138	-89.7953	3	0.0095	8.63	0.60	3.30
464	32.3168	-89.7857	3	0.0095	8.03	0.60	3.29
465	33.3990	-91.0557	7	0.0220	2.88	0.51	1.36
466	32.9787	-88.9013	0	0.0000	N/A	N/A	N/A
467	31.1176	-91.3165	5	0.0160	3.40	0.49	2.38
468	31.1112	-91.3128	5	0.0160	2.95	0.49	2.04
469	33.3994	-91.0469	7	0.0220	2.80	0.51	1.17
470	33.5435	-89.1241	3	0.0095	8.80	5.80	7.63
471	31.6873	-88.6463	5	0.0160	9.65	0.51	4.16
472	31.6946	-88.6449	5	0.0160	9.71	0.51	4.30
473	31.5383	-88.5264	0	0.0000	N/A	N/A	N/A
474	31.6958	-88.8024	4	0.0130	9.60	0.45	7.13
475	31.6963	-88.8100	3	0.0095	9.71	0.45	6.60
476	33.5410	-89.2768	2	0.0064	8.80	0.62	4.71
477	31.0685	-91.3130	5	0.0160	3.40	0.71	2.54
478	33.5462	-89.2682	2	0.0064	8.30	0.62	4.46
479	31.0781	-91.3091	5	0.0160	2.76	0.71	2.04
480	31.0941	-91.2739	5	0.0160	3.00	0.74	2.32
481	31.0773	-91.0649	4	0.0130	9.02	0.57	2.90

Table B1. Sign saturation data for all school zones within the State of Mississippi (Continued)

School Zone #	Location		Density number	Density per sq-mile	Farthest distance	Nearest distance	Average distance
	Latitude	Longitude					
482	31.0993	-91.2848	5	0.0160	2.71	0.74	1.92
483	31.0781	-91.0880	4	0.0130	9.54	0.75	3.38
484	31.0774	-91.0754	4	0.0130	9.25	0.62	2.94
485	33.9784	-89.6750	0	0.0000	N/A	N/A	N/A
486	33.8961	-89.8626	0	0.0000	N/A	N/A	N/A
487	32.6416	-90.4066	3	0.0095	9.06	0.48	6.11
488	32.6394	-90.3988	3	0.0095	8.65	0.48	5.84
489	32.8220	-90.2607	0	0.0000	N/A	N/A	N/A

Appendix C: Accident Data

C1. Summary of number of accidents and average severity of All the School Zones in District 1

Table C1. Summary of number of accidents and average severity of All the School Zones in District 1

	Number of Accidents	Average Severity
Mean	2.544304	1.618481
Standard Deviation	5.215356	2.206262
Minimum	0	0
Maximum	24	5
Count	79	79

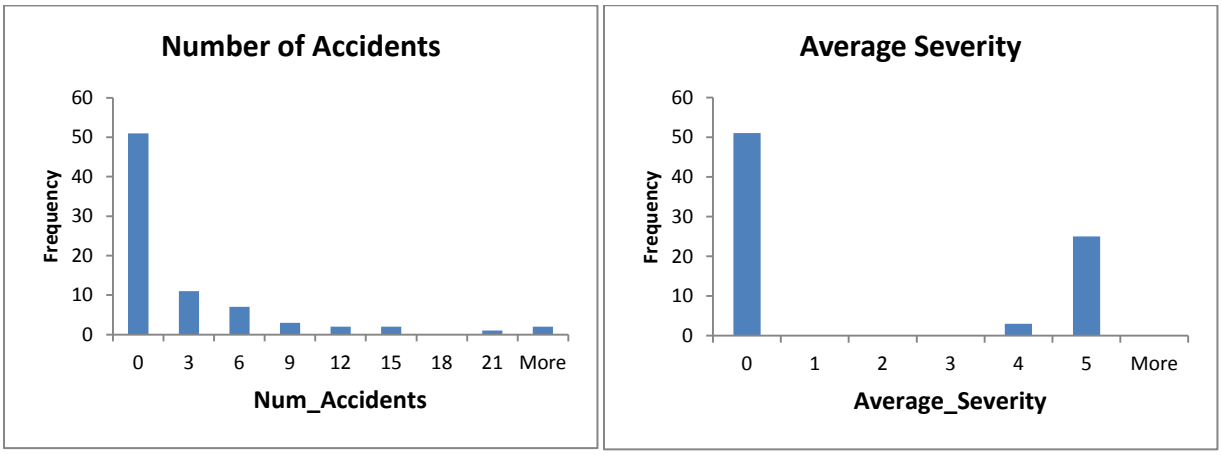

Figure C1. Histogram of number of accidents and average severity of All the School Zones in District 1

Appendix D: Site Details

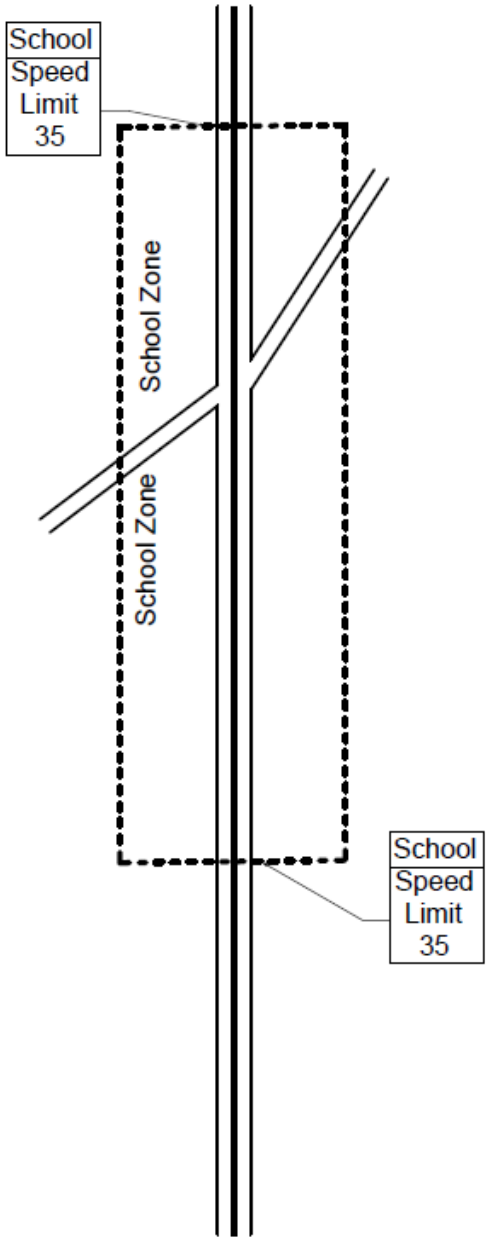

Figure D1. Sketch of school zone A.

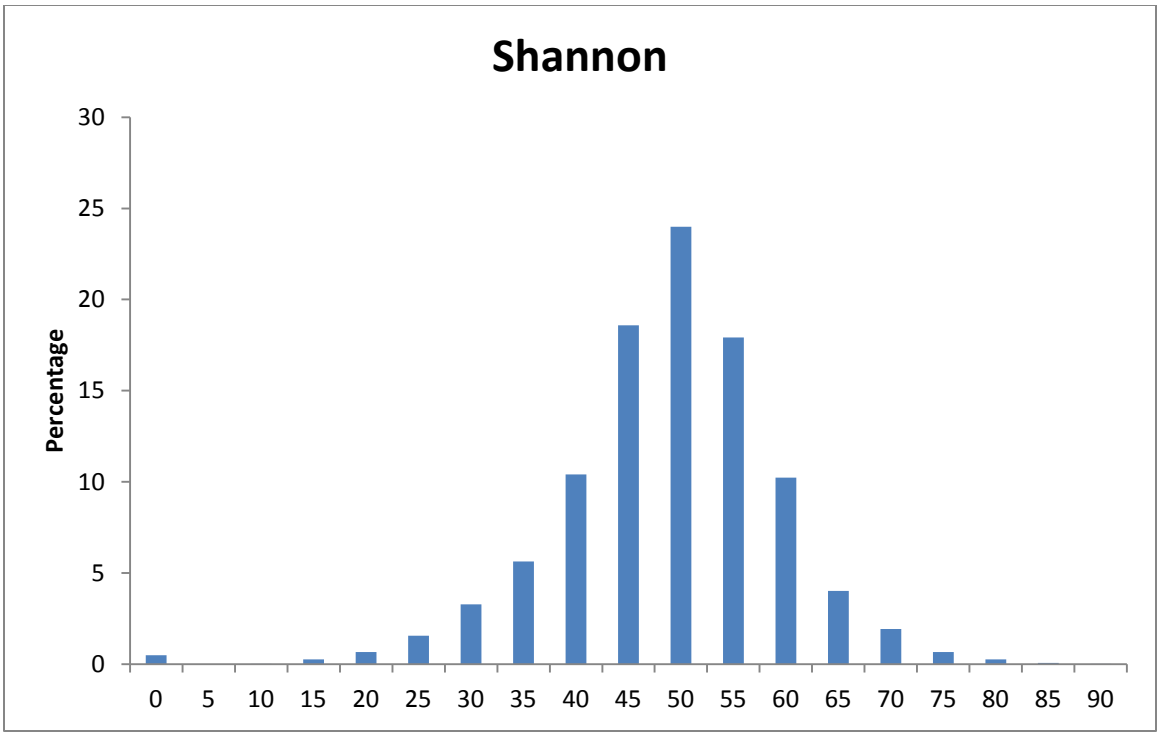

Figure D2. Histogram of the vehicle speeds in school zone A (weekday data).

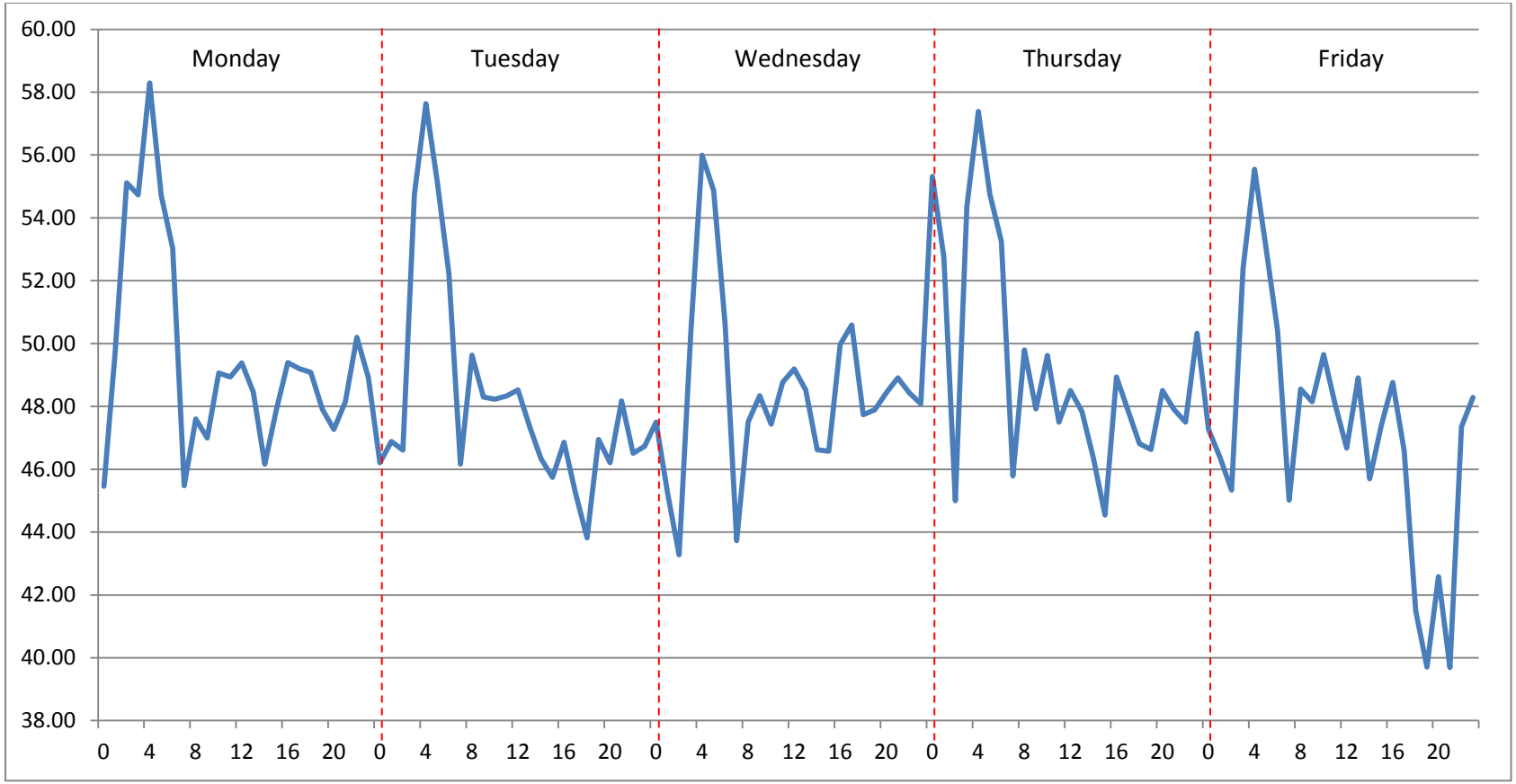

Figure D3. Average speed based on time of school zone A (weekday data).

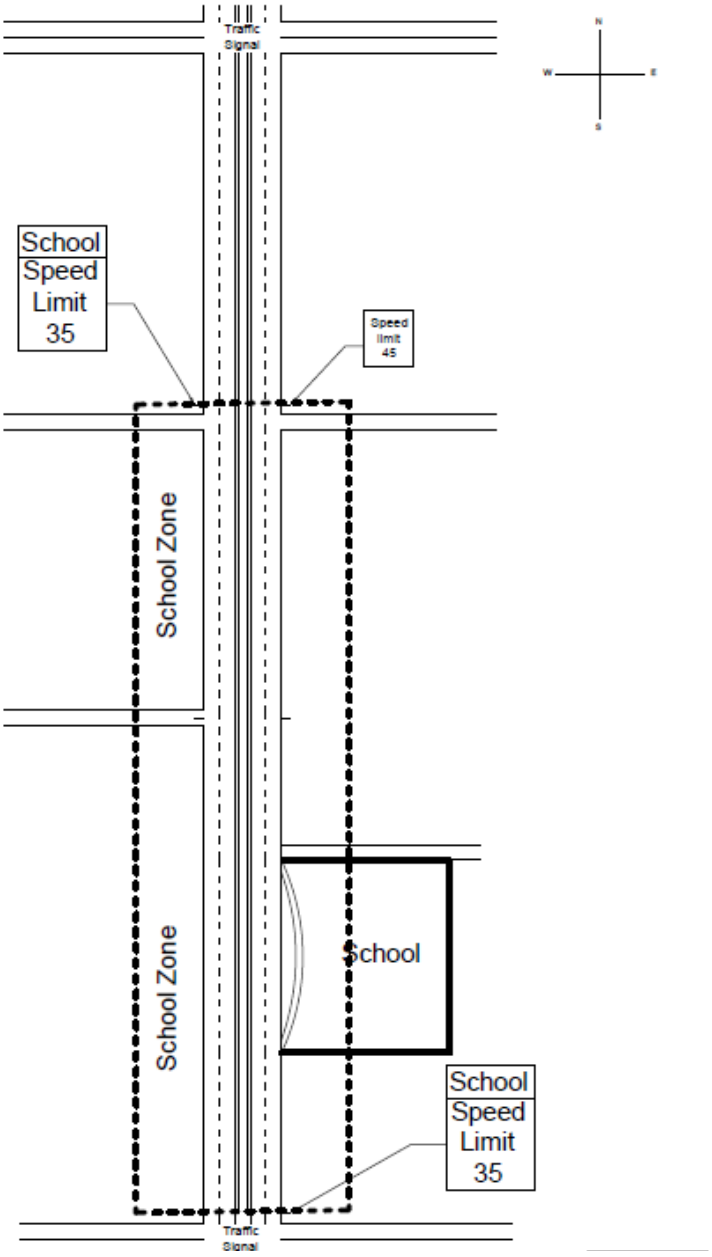

Figure D4. Sketch of school zone B

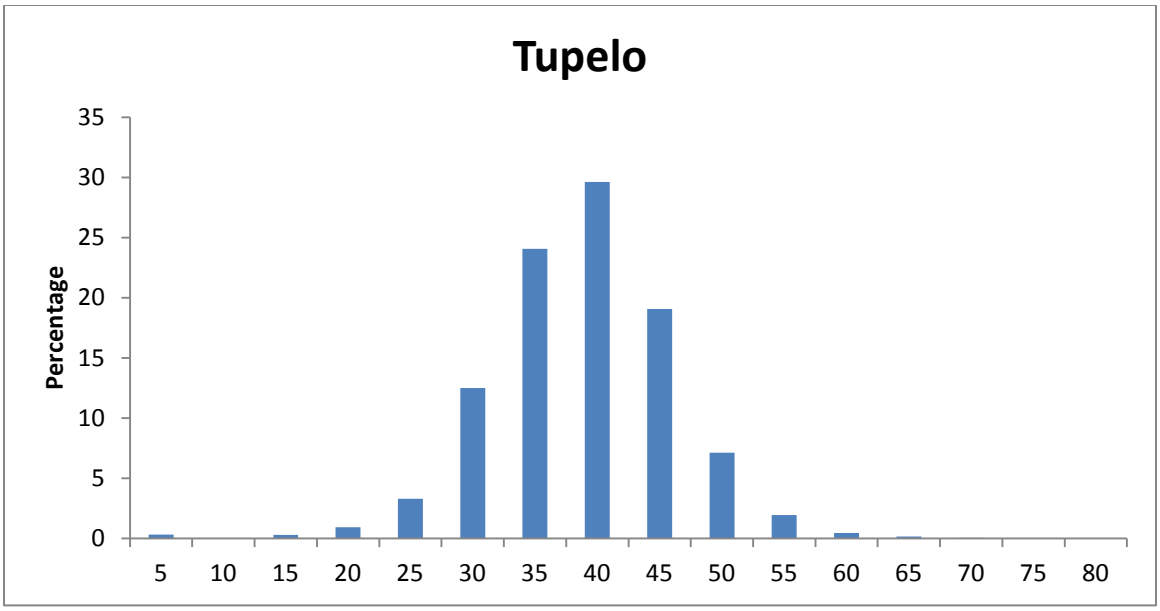

Figure D5. Histogram of the vehicle speeds in school zone B (weekday data).

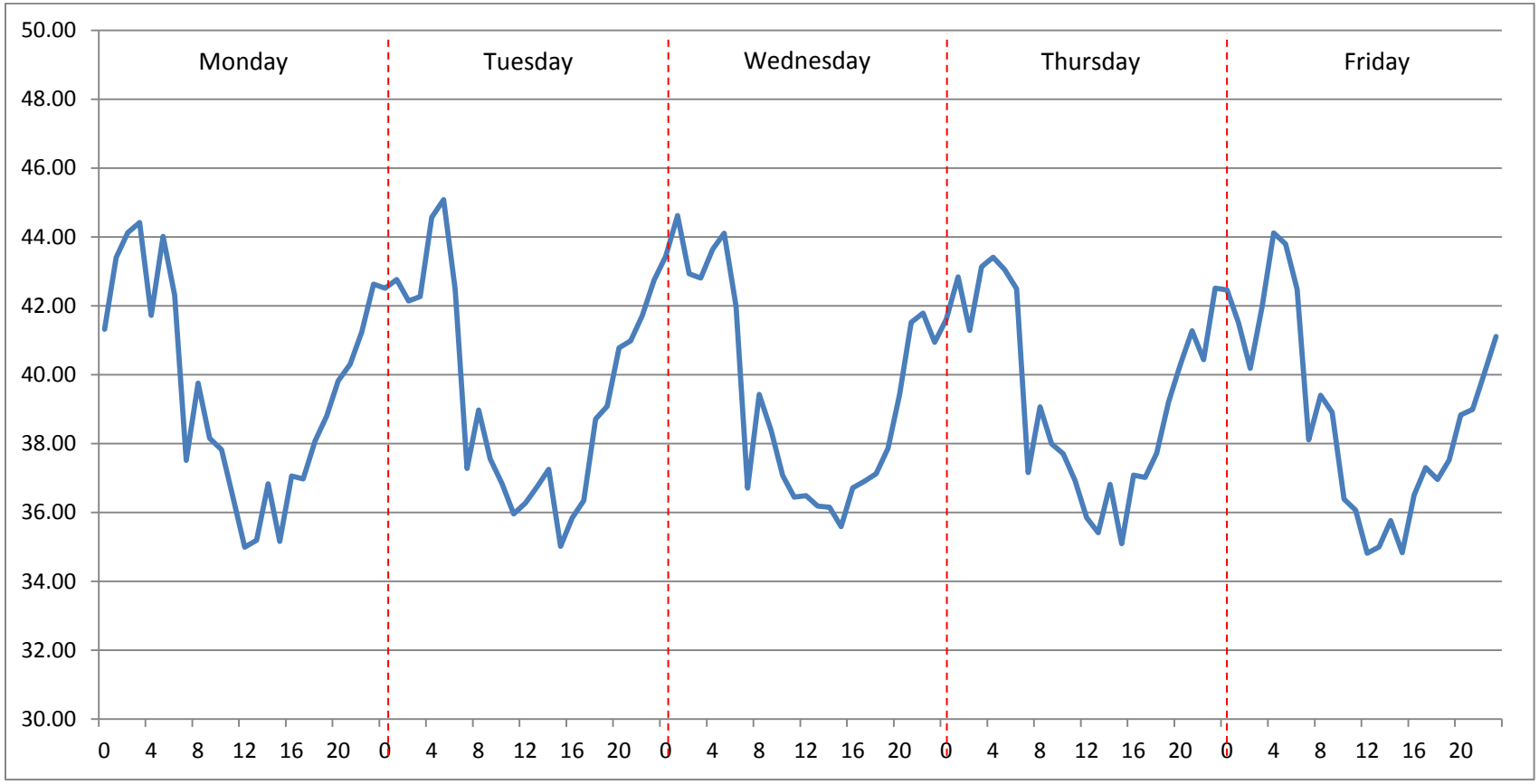

Figure D6. Average speed based on time of school zone B (weekday data).

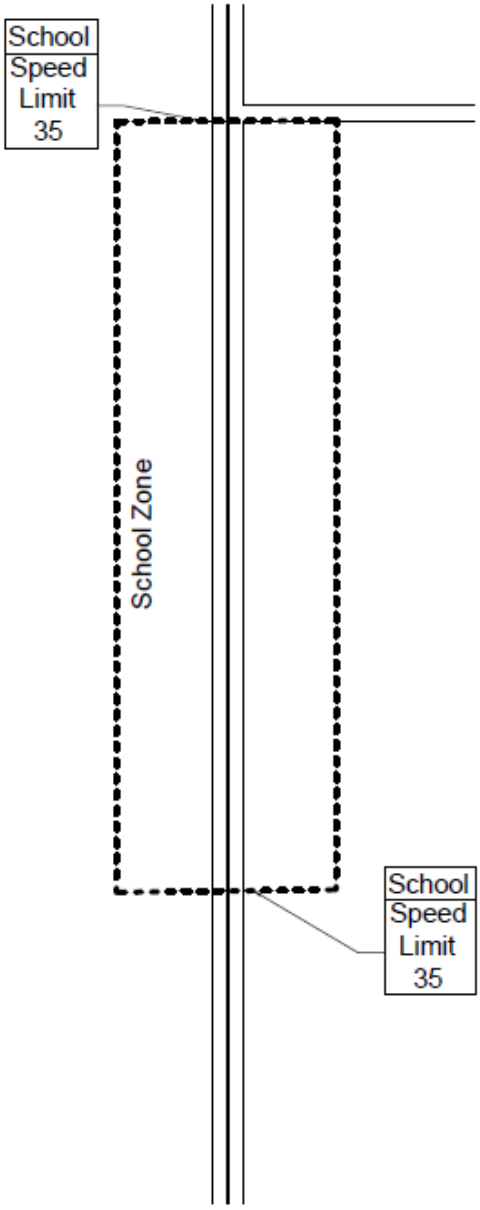

Figure D7. Sketch of school zone C.

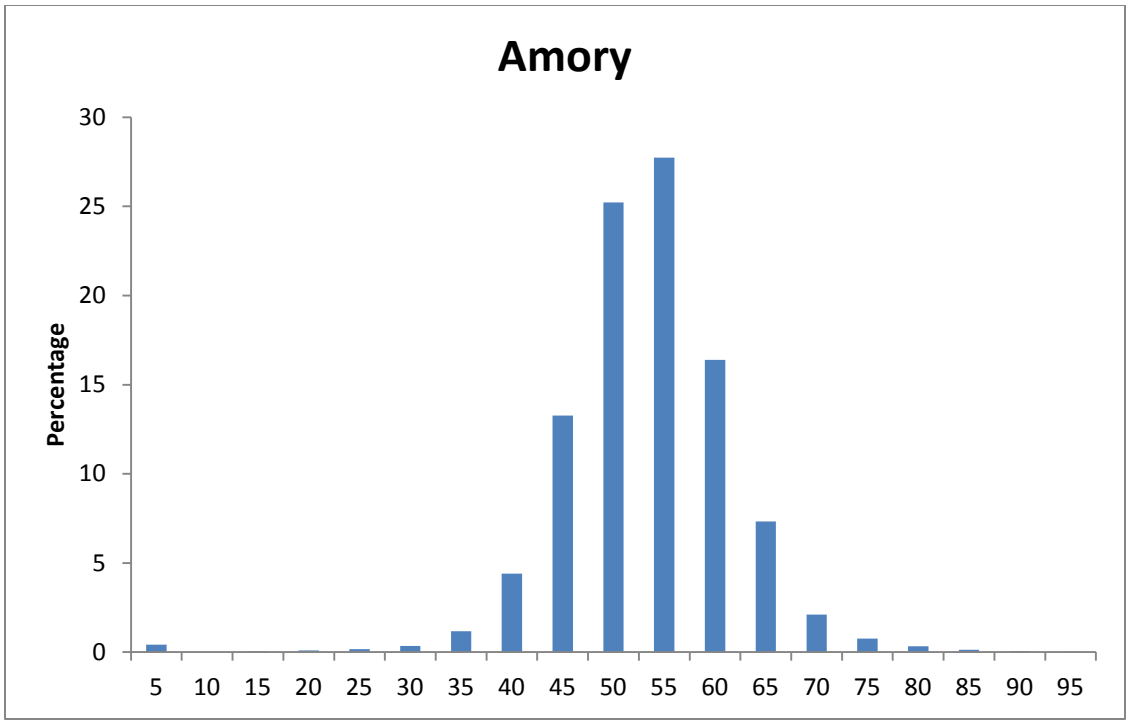

Figure D8. Histogram of the vehicle speeds in school zone C (weekday data).

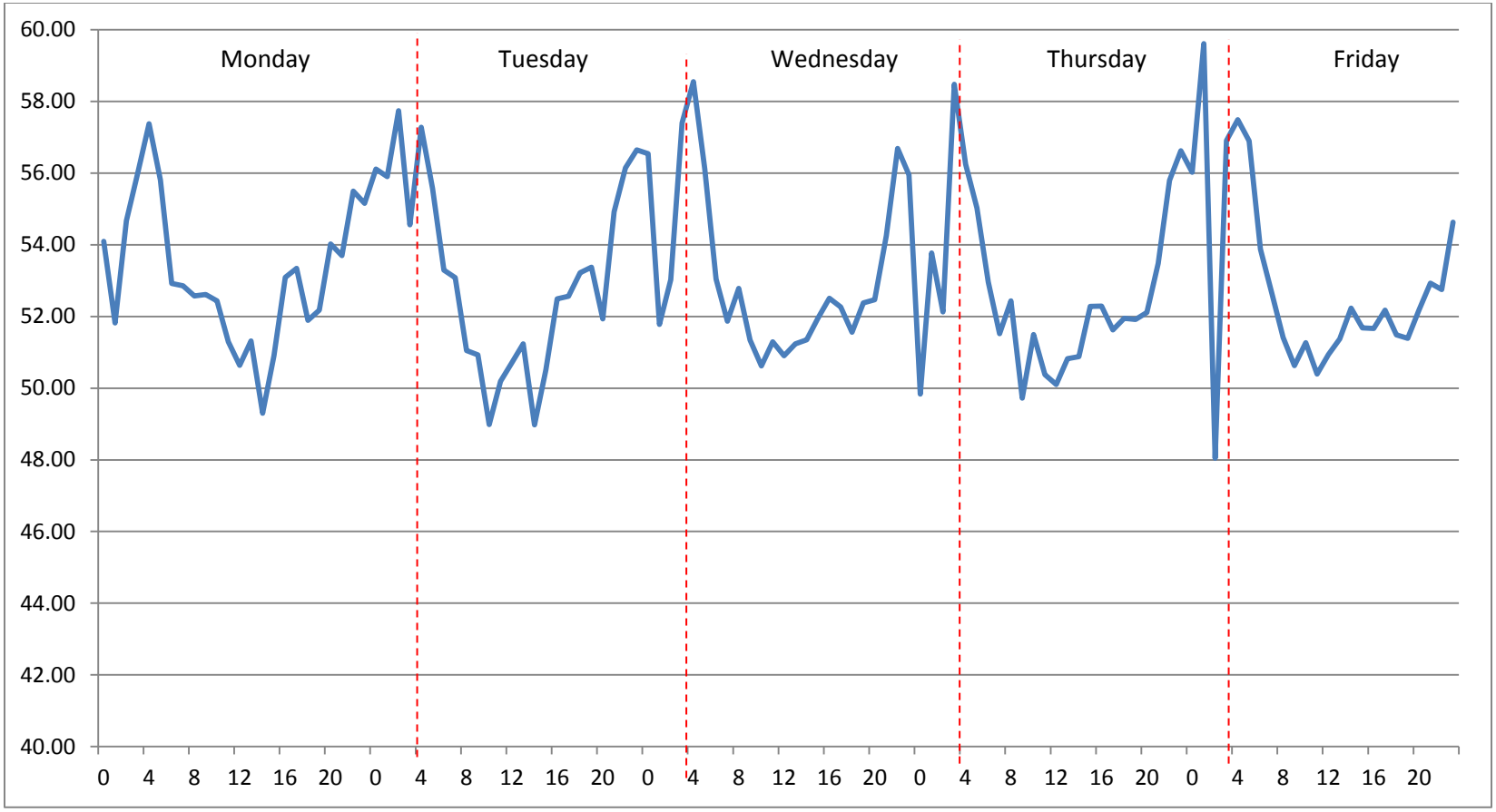

Figure D9. Average speed based on time of school zone C (weekday data).

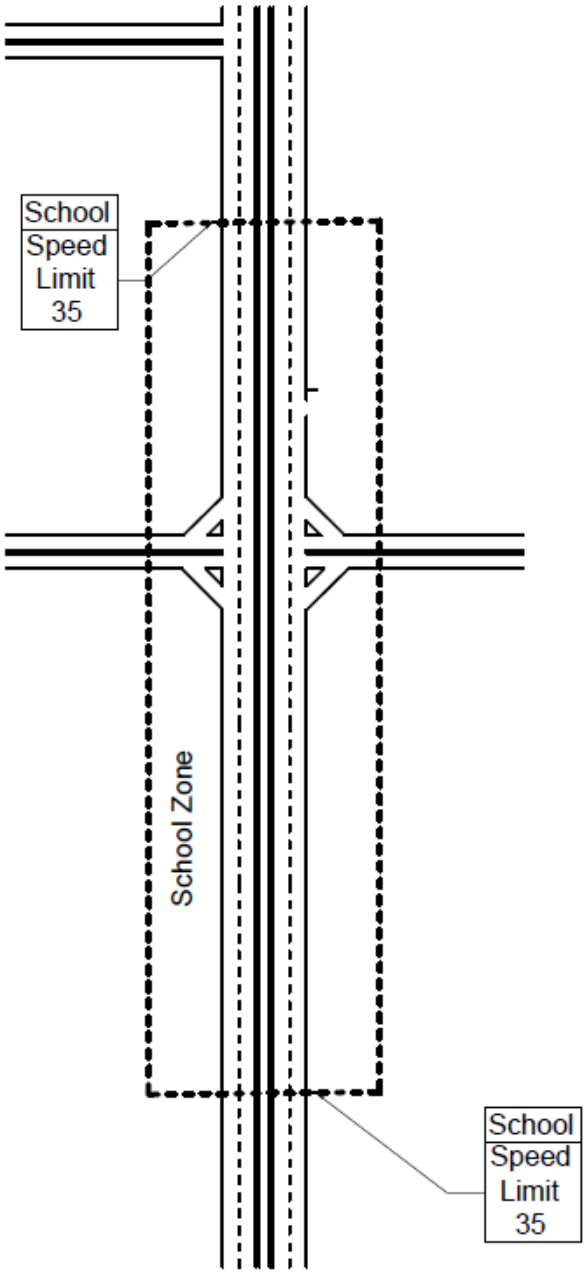

Figure D10. Sketch of school zone D.

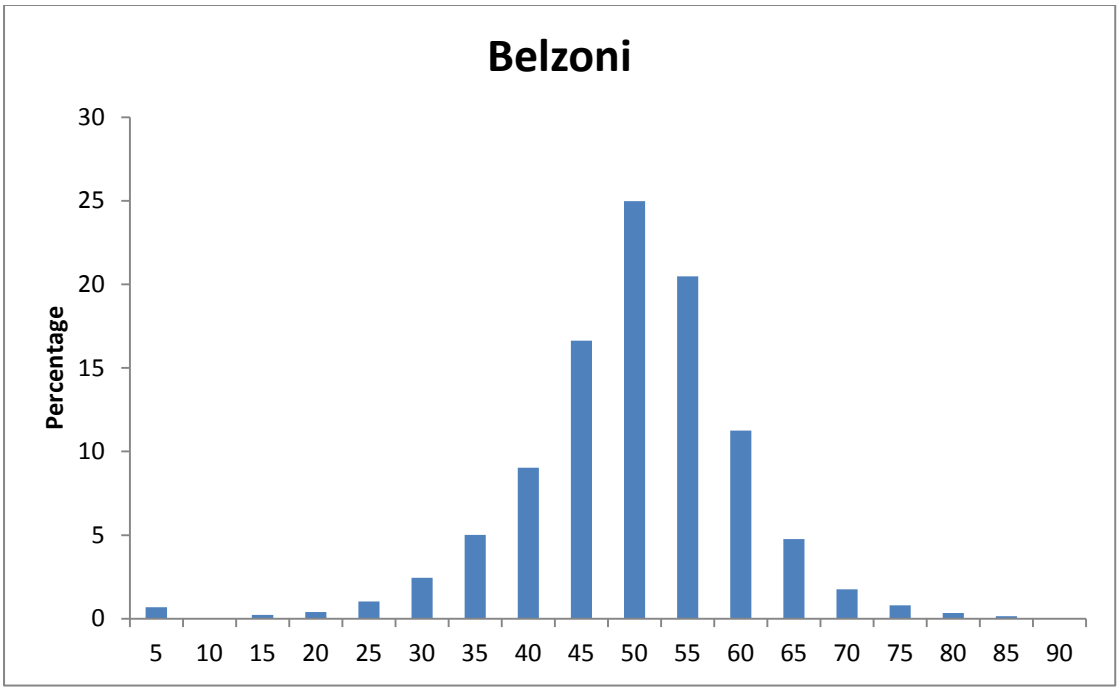

Figure D11. Histogram of the vehicle speeds in school zone D (weekday data).

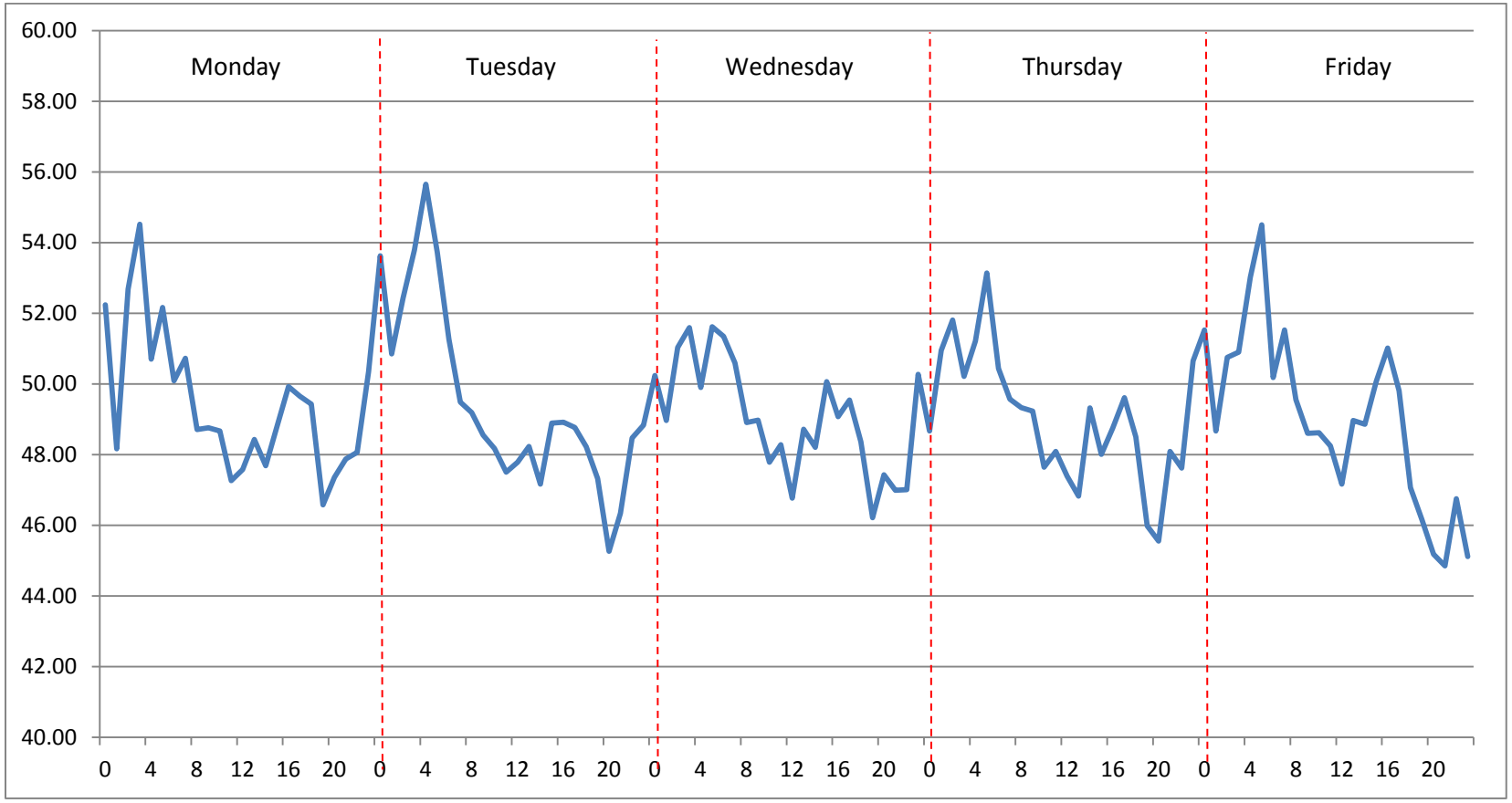

Figure D12. Average speed based on time of school zone D (weekday data).

Table D1. School schedules.

School Zone	Location	Start time	End time	Break time
A	Shannon (Hwy 145 and E Cherry St) 662-767-9566 (Shannon high)	7:40 a.m.	2:56 p.m.	9:24-9:38 a.m.
B	Tupelo (N Gloster St and Leake St)662-841-8920 (Milam elementary)	8:00 a.m.	3:30 p.m.	N/A
C	Amory (Hwy 25 and S Harmony Rd662-256-3223(Becker elementary)662-256-2495	7:45 a.m.	3:02 p.m.	9:24-9:32 a.m. 12:05-12:30 p.m.
D	Belzoni (Hwy 49W and Pluck Rd)662-247-1572 (Humphrey's academy)	8:00 a.m.	3:00 p.m.	10:00-10.15 a.m. 1:00-1:25 p.m.